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Earthquake Risk Perception in Bucharest, Romania

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The Municipality of Bucharest is one of the capitals with the highest seismic risk in the world. Bucharest is particularly vulnerable to seismic hazard due to: the high density of inhabitants, especially within the residential districts with blocks of flats; the old public utility fund; the out-of-date infrastructure; the numerous industrial parks that are undergoing a restructuring process, not to mention the inefficient organization of civil protection and poor education of the population regarding seismic risk. This research was designed to examine the attitudes and perceptions of people living with the risk of an earthquake hazard in Bucharest. We were interested in how attitudes and perceptions differ depending on gender, age, education, residential area and socioeconomic status, characteristics of seismic hazard, degree of risk exposure, degree of danger, and casualty awareness. At the same time, we compare the results of this study with those from a previous and similar enquiry in 1997. The statistical processing has indicated a significant difference between the declared perception of seismic risk and the independent variables of gender, age, level of education, level of attachment to the residential area, and degree to which the subjects consider they may be affected and could retrieve their losses. Due to the continuous decrease of their living standard, the most vulnerable is the aged population. The feelings toward the residential area is another factor of statistical significance for the population's seismic danger perception. A strong affective bond offers a feeling of safety and leads to the neglect and even total denial of the hazard. In the case of independent variables regarding the type of dwelling, its age, and property form, deviations of empiric values from the theoretical distribution are not relevant for the correlation searched for, which indicates that this issue goes beyond the above-mentioned criteria.

KEY WORDS: Bucharest; disaster vulnerability; earthquake hazard; risk perceptions

1. LIVING WITH RISKS

Throughout the world, there is an increasing concern about the occurrence of natural hazards. The number of disasters related to natural hazards and their impact have increased steadily during the past 20 years. Both are due to increased human exposure and/or to an actual increase in the frequency and magnitude of the hazards (EM-DAT database). The social and economic costs of natural hazards are substantial, not only as damages costs, but also due to recovery (Alexander, 1993; Alcántara-Ayala, 2002; Twigg, 2002).

The largest number of disasters worldwide was registered in 2000 (850 disaster events); 14% of them were earthquakes and volcanic eruptions. In 2000, 1 of 30 persons worldwide was affected by natural disasters, while from the total of 9,270 casualties, earthquakes caused approximately 4% (EM-DAT database; NOAA/NESDIS National Geophysical Data Center; U.S. Geological Survey Earthquake Hazard Program).

In the next millennium, it is estimated that significant earthquakes will damage several cities and mega-cities located close to regions of known seismic hazard. These events will wreak great havoc in

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cities in developing countries, where the construction of earthquake resistant buildings is not properly completed or mandated, and the capacity of economies to absorb such shocks has been eroded (Blaikie *et al.*, 1994; Twigg, 2002; Pelling, 2003).

It is predicted that the annual fatality rate from earthquakes will rise in the next 30 years, attributable partly to moderate earthquakes near large cities, but mainly from a few catastrophic earthquakes near super-cities (Office of U.S. Foreign Disaster Assistance and the Center for Research on the Epidemiology of Disasters OFDA/CRED).

For the above-mentioned reasons, it is of great urgency to evaluate human perception of seismic risk in assessing social vulnerability in disaster mitigation through a disaster planning process in large cities.

Seismic risk is the likelihood of loss and it might be defined as the seismic hazard, vulnerability, and costs, i.e., economic loss consequences of an earthquake (Sandi, 1986). The seismic risk is very complex due to the direct or indirect, immediate, or long-lasting effects at the surface of the earth. The direct effect is the result of the earth's crust movements due to seismic waves and/or movements along some faults. Among the indirect and immediate effects of earthquakes, the most devastating for urban areas are demolition of homes, deterioration of roads and utility networks, and fires.

Romania is a seismic country, with approximately 500 earthquakes occurring every year. The expected annual property loss from earthquakes and floods is estimated in Romania at around US$ 400 million (World Bank, 2003). However, compared to Japan, the quantity of seismic energy that is released annually is 400 times less. The seismic hazard of Romania is relatively high, mainly due to the subcrustal earthquakes located at the sharp bend of the southeast Carpathians, in Vrancea region (Fig. 1). This is one of the well-defined seismic-active areas of Europe, characterized by a narrow, near-vertical focal volume subducted at intermediate depths: 60–220 km (Cornea & Lăzărescu, 1980; Rădulescu, 1988; Lungu *et al.*, 1995; Radulian *et al.*, 2000).

During the last 1,000 years, according to historical data, it is thought that 17 earthquakes with 7 and over magnitude occurred, which suggests a mean for unleashing the energy of every 58 years. Statistically, the magnitude 6 and over earthquakes in Vrancea area occur approximately every 10 years, magnitude 7 every 33 years, while those with 7.5 magnitude every 80 years (Constantinescu & Enescu, 1984, 1985; Oncescu *et al.,* 1999).

Bucharest, the capital of Romania, is a populous city (1,996,814 persons, July 1, 2001) with a large building stock, and an important administrative and economic role. Combining these attributes with the seismic hazard induced by Vrancea source, Bucharest has been ranked as the 10th capital city worldwide in the terms of seismic risk, being one of the cities with highest seismic risk in Europe (Bonjer *et al.*, 2003; Arion *et al.,* 2004).

The earthquakes threatening Bucharest are intermediate deep events with magnitudes close to Mw = 8.0 at an almost fixed epicentral distance of about 150 km. The travel-time difference between the destructive S-wave arriving in Bucharest and the

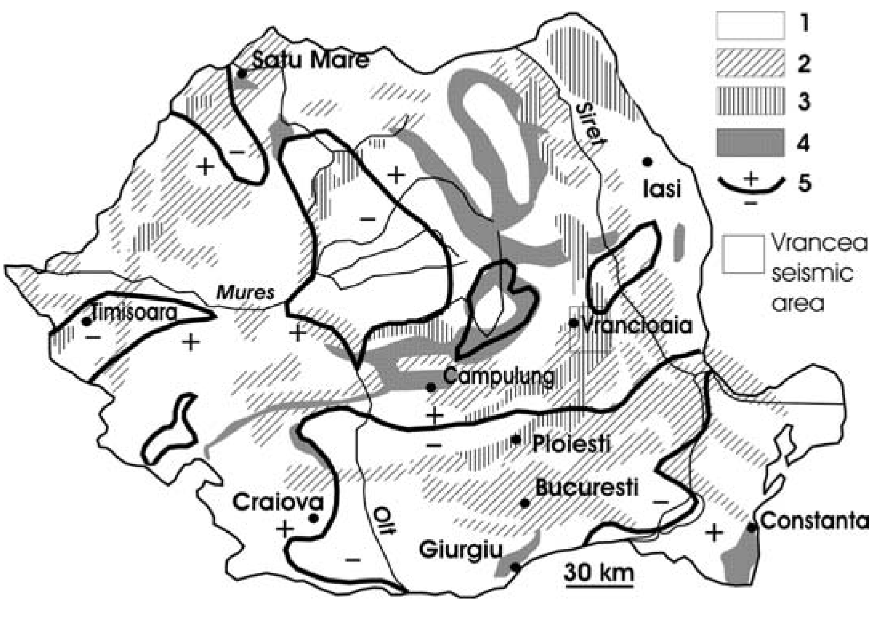

Fig. 1. Seismic hazard map of Romania (updated from Balan *et al.*, 1982). 1. Areas free of seismic hazard; 2. Areas with low seismic hazard; 3. Areas with high (local and general) seismic hazard; 4. Neotectonic movements; 5. Limit for movements of contrary directions.

epicentral P-wave is always greater than 25 seconds, which represents the maximum possible warning time (Wenzel *et al.*, 1999). During the last 65 years, Bucharest experienced four large earthquakes, each having its center located in Vrancea: November 10, 1940 (Mw = 7.7, 160 km deep); March 4, 1977 (Mw = 7.5, 100 km deep); August 30, 1986 (Mw = 7.2, 140 km deep); May 30, 1990 (Mw = 6.9, 80 km deep).

The most recent earthquake recorded in Bucharest took place on June 18, 2005, at 6:17 p.m., the depth of which was 150 km and 5.1 on the Richter scale (www.info.ro, Catalogue, 1998).

The next large earthquake, with a macroseismic intensity in the epicentral zone: I_{Buc} = VII or VIII (MSK-64 scale), is predicted to strike in the window of probability 2006–2008, with a probability value of 67% (Enescu & Enescu, 1996).

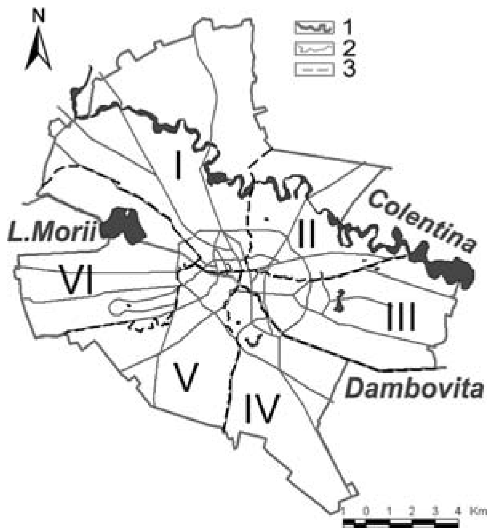

Fig. 2. Sector division of the City of Bucharest: 1. Boundary of Bucharest City; 2. Main streets texture; 3. Sectors boundary.

2. DISASTER VULNERABILITY

A natural hazard only becomes a disaster when it affects a human community that is exposed and vulnerable. Entities at risk are humans, infrastructure, buildings, utilities, etc. Seismic vulnerability of a community is "the degree of loss to a given element of risk or set of such elements" (Granger *et al.*, 1999, p. 3), and is modeled as a composite of sensitivity, adaptation, and exposure to the seismic hazard.

The most devastating earthquake in Romanian history occurred on March 4, 1977, claiming the lives of 1,570 people and injuring 11,300 persons, 90% of the casualties being in Bucharest (7,576 persons). The 1977 earthquake, measuring 7.2 on the Richter scale, resulted in economic losses well in excess of US$ 2 billion (*World Bank Report No.P-2240-RO*, 1978). During and immediately after the earthquake, more than 32,000 houses collapsed or were severely damaged, leaving 35,000 families homeless. Similarly to other big cities hit by strong earthquakes (Caracas, Mexico City), the largest damage was noticed in Bucharest for the high-story and flexible buildings (Mândrescu *et al.*, 2004). In the center of the capital city, 23 buildings with more than seven floors (with reinforced concrete structure and filling bricklaying), five buildings from three to six floors high (carrying bricklaying, built before World War II), and three new buildings (built after 1962 with reinforced concrete) collapsed (*NBS* Special Publication 490, *Observation on the behavior of buildings in the Romanian earthquake of March 4, 1977*).

The 1977 earthquake, although it released only half of the quantity of energy compared to that in 1940, had stronger effects on certain alignments due to its multi-shock character. With respect to its duration, the energy was unleashed earlier than the 58-year mean, i.e., only 37 years after the previous earthquake (that in 1940 followed the 1894 earthquake 46 years later).

Bucharest is located in the alluvial Romanian plain (southeastern part of Romania), on the terraces and interfluves between two small rivers—the Dambovita and the Colentina (Fig. 2)—halfway between the Danube and South Carpathian Mountains. The total urbanized area is of 228 km^2.

The dwellings in the capital city are part of 32 residential areas divided up into six sectors. Sector 3 has the largest population—20.3% (July 1, 2001). The mean population density in Bucharest is 10,806 persons/sq.km (1992 National Census). The GDP per capita for Bucharest is 2,988 US$ (1998—*Romanian Statistical Yearbook*). The inventory of housing units based on when they were built indicates that from the total number of apartments in Bucharest: 22% were built before 1941, 8% were built between 1941 and 1963, 30% between 1963 and 1977, and 40% after the 1977 event.

Sector 3 characterizes best the territorial and historical development of the city. It includes the historic center of Bucharest, being at the same time the sector with the most diverse variety of textures of the urban network, generated by the road patterns, degree of land occupation, and the height and size of buildings. Its core, the historic area, is circled by a concentric ring of urban framework characterized by large areas that were subject to demolition during the Communist period, now composed of unfinished blocks of flats and buildings. Outwardly, there is an area with blocks built during the 1950–1980 period, where "islands" of the original pre-Communist urban framework may still be seen. The ring of blocks of flats is delineated by the large industrial parks at the outskirts of the town that are undergoing a profound restructuring process, which are surrounded by individual, yet modest dwellings.

Should an earthquake similar to that in 1977 occur during the night, the most somber scenarios conceived by the Building Research Institute, Bucharest (INCERC) (www.incerc.ro) indicate that the population of the capital city would drop by almost half (450,000 casualties). Approximately 6,500 people would stand no chance of survival since they live in one of the 1,000 buildings that are technically labeled to be in a state of "total or partial collapse." Another 95,000 people would have to face the trauma of being prisoners of their own dwelling places, not to mention the 16,000 people severely injured (Lungu *et al.*, 2000). The estimated number of victims would be 46% lower if the earthquake occurred during the day when most people would not be at home.

In the city ($\chi^2(10) = 23.2$, $p > 0.01$), there are 23,000 vulnerable dwelling buildings that will be severely damaged by an earthquake (from a total of 108,834 buildings). Most of the buildings in the Ist and IInd seismic risk category[1] (categories of most great seismic vulnerability), having more than four floors in addition to the ground floor, lie in the historical center of the capital and were built between 1875 and 1940. The 19th-century buildings are built over basements dating from the 18th century. The Communist system had a continuous policy designed specifically to lead to the decay and degradation of the historic center. For instance, there was no program to reconstruct and improve the infrastructure following World War II. As a consequence, the former owners left the buildings, which have decayed ever since, many of them being in ruin today. These buildings are now occupied by a population of modest means, many of them illegally living there.

The historic center includes 21 buildings of type ground floor plus four (ground floor + up to another four floors), included in the Ist category of seismic risk, where 1,429 persons live. The IInd category of seismic risk includes 16 such buildings, housing a total of 753 persons. From all the catalogued buildings, only five of them have commercial functions.

Sector 2 includes most of the blocks of flats with high seismic risk—185 of them, with only 32% of the population with access to shelters.

Fragile blocks of flats made up of reinforced concrete, with average height (up to 5 or 7 floors), built before 1940, face *the greatest seismic risk* (Lungu *et al.*, 2000). The same is true for *buildings with vital functions* (hospital, fire stations, ambulance stations, civil protection buildings, police stations, communication centers, etc.). It is estimated that half of the hospitals will collapse since they are old buildings that have not been repaired from the damage from previous earthquakes. From the 57 hospitals in the capital city, 25 of them (eight having emergency rooms!) must be immediately repaired. If the earthquake occurs during daylight, most of the young population who attend school will be concentrated in the education institutions, many of which have great seismic vulnerability. Thus, from the total of 105 schools, only 45 are being modernized with the help of EBRD funds (European Bank for Reconstruction and Development).

Vulnerability elements are related to the old infrastructure of the city—such as the gas and water pipe networks. From this point of view, Sector 4 has the most numerous complaints about sewage bursting out in the streets, with 22 streets and large boulevards having to face this problem. Taking all this into consideration, seismic waves may easily tear into pieces the moist concrete.

The consequences of an earthquake would not be related only to fires and buildings collapsing; there could also be floods. If an earthquake were to destroy the dam of Morii Lake (Fig. 2), it would overflow, flooding the entire western, central, and southern parts of the city. Overall, the direct economic losses would amount to 1,744,554,766 Euro (Arion *et al.,* 2004).

3. SCIENTIFIC BACKGROUND

Substantial literature has accumulated on environmental risk perception since the late 1960s. Primary research focused on the nature of environmental risk perceptions, measurement considerations, and correlations with attitudinal and personal characteristics (Slovic, 1962; Kates, 1971; White, 1974). Although the first studies on risk perception go back to the early 1960s, the concept of "perceived

[1] The classification of existing building stock with respect to period of construction, structure type, class of seismic risk (I–IV) by the Minister of Public Works (Order No.6173/NN/1997).

risk" became prominent in the mid 1970s (Slovic *et al.*, 1977, 1980).

A prevailing assumption is that people who perceive a relatively high risk of an adverse event are more likely to take personal ameliorative steps and support government initiatives to do likewise, even in the face of required sacrifice (Armaş *et al.*, 2003). This assumption, however, has seldom been tested.

The way individuals perceive their vulnerability to natural hazards shapes their reaction and ways of coping with these risks; hence their cost (Schumm, 1994). Slovic (2000) noted that if people perceive a risk to be real, then they would behave accordingly. Just as we monitor the quality and safety of the environment, we must also monitor the values that people use to anticipate, make decisions about, resist, and recover from the impact of a natural hazard.

Natural hazards are typically viewed as involuntary risks, but preparing the household for an emergency, for example, is a voluntary response to this unchosen risk. Standard household insurance does not cover earthquakes, but homeowners can purchase coverage for an additional premium. Recent studies have shown, however, that Canadians and Americans underestimate their vulnerability to earthquakes and the likelihood that any resulting loss is covered by insurance (Palm, 1990).

Early research investigating strategies for studying perceived risks involved the development of the psychometric paradigm by Fischhoff *et al.* (1978). The paradigm investigates the means by which people make quantitative decisions on their perceived risk from a situation and is widely referred to in the literature (Jasanoff, 1998; Slovic, 2000). However, the role of risk "perception" can also be of significance when studying social vulnerability measures.

Various natural hazard assessment studies measure the vulnerability of people and communities using different indicators, and acknowledge that social vulnerability is as much a part of risk as building damage, hazard magnitude, and economic loss (HAZUS 99; The Earthquake Disaster Risk Index EDRI, developed by Rachel Davidson in 1997; Ferrier, 2000; The Cities Project, developed by Granger *et al.*, 1999, 2001). The indicators are generally considered to be independent and equally important variables, and the effects of a combination of particular indicator values compared with other combinations are not explored.

The Romanian literature contains hardly any studies about environmental risk perception (Sorocovischi, 2002; Armaş *et al.*, 2003). This type of enquiry is closely connected to democratic systems where much of the citizens' lives are shaped by the results of sample surveys. For Bucharest, the only research to evaluate the perception of seismic risk was conducted by Armaş and Neacşu in 1997 (published in 2003). The present study seeks to evaluate how the results since 1997 are confirmed or have changed.

The aim of this article is to monitor earthquake hazard perception, which is an important aspect of urban hazard mitigation. Capturing information regarding people's perception of risk is valuable in understanding people's behavior. Scientists and decisionmakers perceive risks associated with hazardous events differently from the public (Dwyer *et al.*, 2004), so it is important to understand public perceptions of earthquake hazard within an environmental context.

4. RESEARCH METHODS

4.1. Participants

Interviews were structured using a 39-question instrument, which was administered in September 2004 by student interviewers from the Faculty of Geography, University of Bucharest. Our questionnaire was divided into three parts: (1) demography (age, gender, occupation, religiosity, economic status, where they live, etc.), (2) perception of seismic risk, the unforeseeable phenomenon; the possibility of being affected by it and to suffer losses; the degree of expectation for getting support from authorities, and (3) the level of adaptation to seismic risk, including the education about minimizing risk.

These items were turned into *state* (the presence or the absence of the phenomenon) and *intensity* indicators and then they were included in the questionnaire as samples of questions with multiple answer choices.

The sample was randomly composed (simple random sampling) and the subjects were self-selected as willing to talk about earthquakes.[2] We tried to make the response categories as broad as possible.

Although there are other methods of selecting a sample, such as postsurvey or telephone interviews, we choose the face-to-face method because the return

[2] We are aware that the participants are not representative of the Bucharest population in terms of age, gender, and education, and that it is possible that the survey did not take into account the whole range of positions, because self-selection works as a filter. Actually, it is not possible to know how people who did not want to be interviewed perceive risk. When we tried to find out why they refused the interview, most of them told us they were in a hurry, but a few answered that it is not an important issue to be discussed.

rate is very high compared to other methods (Marans, 1987). When approached with an explanation of what we were doing (and why), most respondents readily agreed to be interviewed, 70% of them being friendly and cooperative. There were 57 denials (32%), 47% of them pertaining to females subjects. The one-way analysis of variance (ANOVA) test does not indicate a significant difference because the female subjects were more numerous (60%). However, the interviewed subjects were more responsive when they were approached by a single operator than when there were pairs ($\chi^2(8) = 17.8, p > 0.02$).

We interviewed 220 persons from all sectors of the capital. Sector 3 is best represented since it has the maximum percentage of the capital's population. Here, the majority of persons are aged 20 to 59 (62%). This choice is explained also by the major social problems the population of this sector has to face as a result of restructuring the Romanian post-Communist economy, most of the inhabitants having worked in industrial units before 1990. The varied urban texture is the result of the evolution of the city as it gradually absorbed the neighboring settlements. The very high percentage of subjects living in blocks of flats (90%) compared to house dwellers is due to the peculiarity of urban habitat and of the multiple historical restructuring actions it went through; here, the Communist system has left the most dominant mark by systematically obliterating the individuality of the old city, and standardizing its image with blocks of flats. This situation is totally different from the distribution of household types in industrial nations, with over 70% of the population living in a house, and urban areas marked by a gentrification process (Fellmann *et al.*, 1992; Dwyer *et al.*, 2004).

Fifty four percent of interviewed flat inhabitants live in blocks built before 1977. Most of the blocks have two groups of flats (19%) and four flats on every floor (47%). The blocks with two to three floors are predominant for the studied sample (they comprise 15% of the type of blocks and 14% of the type of analyzed buildings), followed by those with four and five floors (approximately 12%).

Following the regime change in 1990, 84% of the subjects bought the apartments they were living in from the state, becoming owners.

The interviewed persons were 55% male and 46% female, most of them aged 15 to 35 (45%) and up to 55 (39%). In this application, it was decided to use residents aged 15 years and over that have responsibilities in household maintenance.

From the education point of view, 55% of the subjects have graduated from high school or vocational school, another 40% having from graduated college, of young persons who have not turned 35 yet, 20% have graduated from college; while the subjects aged 46 to 55 have only average education (25% of the persons in the same age category and 14% of the sample). The independence chi-square test indicates a significant link between age, evaluated on six value classes, and education level, divided into three parts ($\chi^2(10) = 23.2$, $p > 0.01$). This education difference is another characteristic inherited from the Communist period—an expression of the forced industrialization of the Romanian economy and ideology based on "the supremacy of the working class." The sample includes all sorts of jobs, uniformly distributed among economic sectors, with workers from industry, commerce, education, business, and medical occupations. Retired persons account for 16%, while 5% are unemployed.

4.2. Measures

How each person will fare in the event of a natural hazard is influenced not only by exposure to infrastructure, but also by personal attributes, community support, access to resources/services, and governmental management.

The aim of this study focuses on seismic hazard perception. We were interested in how attitudes and perceptions differ according to gender, age, education, residential area, social and economic status, characteristics of seismic hazard, the extent to which one is vulnerable to the risk, becoming aware of the danger, and loss perception. Another issue was to test the degree of adaptation to seismic risk according to the extent to which the danger is acknowledged (but this is not the subject of this article).

The indicators chosen for this study, listed in Table I, have been selected from extensive literature reviews, discussions with researchers, and previous experience in risk perception surveys. Indicators 1 to 9 are socioeconomic, while "Resilience Capacity" is a social vulnerability indicator, and "Losses" is a hazard indicator relating to the impact of an earthquake. Other variables that provide an insight into an individual's characteristics include less tangible factors, such as psychological aspects (Indicators 12, 13, 14).

Although not exhaustive of factors that contribute to a person's relation toward the seismic hazard, this set of variables should provide an indication

Table I. Indicators of a Person's Earthquake Hazard Perception Used in the Study

Number	Indicator	Selected References
1	Age	Davidson, 1997; Granger *et al.*, 1999; King and MacGregor, 2000; Pelling, 2003
2	Gender	Granger *et al.*, 1999; Fordham, 2000
3	Income	Granger *et al.*, 1999; Dwyer *et al*., 2004
4	Residence type	Bolin and Stanford, 1991; Dwyer *et al*., 2004
5	Property form	Young, 1998
6	Employment	Buckle, 2000
7	Education	Buckle, 2000
8	Household type	Granger *et al.*, 1999; King and MacGregor, 2000; Buckle, 2000
9	Savings	Dwyer *et al*., 2004
10	Resilience capacity	Young, 1998; Pelling, 2003
11	Expected residence damage and losses	*HAZUS 99 Technical Manual*
12	Perception of risk	Kates, 1971; Fischhoff *et al.,* 1978; Jasanoff, 1998; Heijmans, 2001; Johnston *et al.*, 2005
13	Understanding of hazard	Kates, 1971; White, 1974; Granger *et al.*, 1999; King and MacGregor, 2000
14	Trust in authority figure	Jasanoff, 1998; Fordham, 2000

of how people perceive earthquake risk in Bucharest and how they relate with the event of a natural hazard impact.

The raw data gathered from the empirical research were statistically and descriptively analyzed, based on the determination of the *absolute* and *relative frequencies* of the multiple-answer choices for every question.

We used Pearson's chi-square test to examine the connection between variables and to test the validity of the working hypothesis, at a significance level of $p < 0.05$.

5. SIGNIFICANT RESULTS AND DISCUSSIONS

The main aim of the research was to compare the way the subjects declared that they perceived seismic danger in Bucharest with demographic, economic, educational, hazard, and vulnerability factors, as well as the manner in which people referred to a random event (Table II). In the context of the population's vulnerability concept, the research was structured in testing the relational patterns of the seismic hazard perception on three levels: the level of personal characteristics (variables like gender, age, and studies were included), the level of environmental security (hazard belief, knowledge of the safety of the home, degree of waiting for the event to happen, the belief about being harmed and expected losses, the affective bond with the area, hope for help in case of a disaster), and the level of economical independence (freedom of locative choice, type of property, resilience capacity).

The declared perception of seismic danger emerges from the answers given to one of the items: "Does the probability of an earthquake hitting Bucharest affect your daily life?" The possible answers implied a decreasing scale, from 1 (very much) to 3 (not at all). If the answer was affirmative, the subject was asked to say what came to his/her mind when thinking of such a scenario. The most often encountered answers referred to the fear of building collapse, injuries, and their own death or the death of beloved ones. These answers match the hazard scenarios described by Dwyer *et al*. (2004), using decision-tree analysis. Dwyer noted that the indicator "Injuries" is perceived as the most important discriminator for individual vulnerability. Injury will affect a person's ability to recover, regardless of personal attributes such as income or age.

If there was a negative answer, the subject was also asked to explain his/her attitude. The most frequent motivation indicates the immediate pressure of other current problems, mostly economic ones, but also the uncertainty of an event that gives no warning.

The descriptive analyses indicate that although all interviewed subjects have experienced at least one earthquake, only 10% of them live with the constant fear of this danger, 54% being completely indifferent. Compared to the data gathered in 1997, on 120 subjects, the values are about 10% lower or higher, but only for the extreme attitudes (Table III).

When applying a nonparametric binomial z-test for two nonrelated samples we see that the difference in the high perception level is significant between 1997 and 2004 (for an alpha = 0.05 bilateral, $z = 2.66$). The ever-increasing pressure of economic problems

Table II. Significant Risk Perception Indicators Established in This Study

Independent Variables		Earthquake Risk Perception (% Within-Risk Perception) High	Low	Significance
Gender	Male	38	67	0.001
	Female	62	33	
Age	15–25	14	24	0.01
	26–35	14	16	
	36–45	14	20	
	46–55	19	24	
	56–65	10	14	
	Over 66	29	4	
Education	Low	29	1	0.001
	Medium	48	52	
	High	23	47	
Hazard relate	Soon	39	3	0.001
	Several years	42	35	
	Never	19	35	
	Don't know/no answer	0	27	
Desire to leave Bucharest for a safer place	Yes	33	11	0.009
	No	67	89	
Residence area motivation	Affective link	10	20	0.005
	Facilities	15	32	
	No other option	75	48	

may explain this effect on daily life during the last several years, which has led to the concentration of the individual's energy and attention to immediate issues of existence. The category of persons with a moderate attitude toward seismic risk hardly changed.

Testing the gender repartition confirms also a significant link between the way people react to this danger (from fear to indifference) and the subject's gender ($\chi^2(2) = 13.7$, $p < 0.001$). Over 13% of the interviewed females consider that the fear of an earthquake dramatically influences their lives. They account for 62% of the sample subjects who constantly live with the fear of an earthquake. This aspect agrees with the outcomes of the Cities Project that women are more vulnerable to natural hazards than males (Granger *et al.*, 1999; Granger & Hayne, 2001). Some researchers have demonstrated that women are better able to come together to support each other and recover more quickly than males (Fordham, 2000).

The fact that women generally better acknowledge the seismic risk relies on the more profound perceptual implication of females in the environmental context, a finding that has a large scientific background in experimental psychology. This fact is underlined in this study by the constantly lower frequency of the "I don't know" answers— typical for those who are not interested in the issue or those who have an ambiguous opinion or none at all it (Rotaru & Iluţ, 1997).

Gender has traditionally been regarded as an important factor in assessing the vulnerability of individuals, yet is not considered of high relative importance when analyzing vulnerability to natural hazards (King & MacGregor, 2000; Buckle, 2000).

Correlating seismic fear with the age variable, evaluated on six categories ranging from 15 to over 66 years old, a significant difference appears in perceiving seismic risk as people age ($\chi^2(10) = 21.9$, $p <$

Table III. Perceived Seismic Risk (1997, 2004)

Year	Constant Fear: Abs. Frequencies	%	Moderate Perception: Abs. Frequencies	%	Indifferent: Abs. Frequencies	%	Total
1997	21	18	47	39	52	43	120
2004	21	10	81	36	118	54	220

0.01). Of those who admit to living in constant fear of earthquakes, 29% are over 66, and the maximum indifference characterizes the 15–25-year-old persons. The differences are even greater if attention is shifted to the female subjects, where 50% of the persons aged over 66 have a permanent fear of seismic danger. This can be explained by the fact that the elderly are the most vulnerable population category. This aspect is also highlighted by the Cities Project, which found that those over 65 are more vulnerable (Granger & Haynes, 2001), and recent studies from sociology, psychology, and medicine on the way elderly people react to disasters (Ngo, 2001). A review of the literature on how the elderly respond to disasters indicates that there are patterns of vulnerability based upon social, psychological, and physiological dimensions (Ngo, 2001). People in this age demographic are generally retired and often have all their finances invested in the house they own. Hence any major damage to the home could put a strain on their finances, as they are less likely to have an ongoing source of income. Older people will also take longer to recover from mild to serious injuries (Dwyer *et al.*, 2004).

For Bucharest, when comparing the present results with those since 1997, there is a clear differentiation in the perception of various age groups during this period. Lately, uncertainty and insecurity, as well as the ever decreasing life standard that has dramatically affected especially the elderly population, have led to an increase in vulnerability and the perception of danger growing acute.

In a more recent survey (spring of 2005), focusing on the old historical center of Bucharest, an enclave of high vulnerability of the buildings and a great vulnerability of the people, we observed that when referring to the seismic hazard *in a very poor population* (half of the sample living under the poverty boundary), *its perception transcends the demographic indicators* (gender, age, education). In the sample of 100 subjects from the old historical center of Bucharest, we could only see a greater consistency in women's answers. This aspect is also maintained in an analysis made only of the population that was affected by former earthquakes. The feminine population is more concerned with the seismic hazard, but the correlations do not overcome the chi-squared signification limit. The aspect is even more important when we see that temperament is manifesting as a gender particularity ($\chi^2(1) = 10.7$, $p < 0.001$). The percentage of those more easily scared is significantly higher in women. While analyzing the frequency of the "no, I am not easily frightened" answer in the male population we must also consider that this opinion has a cultural dimension. Also, the temperament meaningfully relates to the subjects' sensitivity ($\chi^2(1) = 14.4$, $p < 0.001$) and to the presence and importance given to the phenomenon in everyday life ($\chi^2(2) = 6.0$, $p < 0.049$). Persons who generally are more easily frightened have more often the sensation that an earthquake strikes, no matter the floor or the type of building they live in, irrespective of the social and economic factors. In the people who are easily frightened, the awareness of danger is higher.

On the tested sample for Bucharest, the education level is closely connected to the extent to which people are aware of the seismic danger ($\chi^2(4) = 31.4$, $p < 0.001$), in the sense that highly educated people, most of them being young, too, are rather detached (47%). Almost 63% of the highly educated people pay no attention to this matter. The most vulnerable to the fear of an earthquake are those with average education. If we also consider the subjects' gender, women with average or elementary education are most afraid ($\chi^2(4) = 21.5$, $p < 0.001$). More than 85% of the women who declared always living with this fear have only average or elementary education.

With regard to coping with the threats of seismic hazard, people seemed to "misperceive" risks, that is, they underestimated the probability of this event, or even denied that there were any risks (Slovic *et al.*, 1974). The specific way humans relate themselves to random events, either by an absolute determinism or by believing there is a well-established recurrence, emphasizes a significant link with the danger perception ($\chi^2(8) = 40.7$, $p < 0.001$). In our sample, only 9% expect a large earthquake to happen soon, 29% think it will happen in several years, while 29% do not believe that there will ever be such an event in Bucharest. Those living in constant fear of seismic danger also believe that a major earthquake is about to happen (almost 40% of those permanently afraid believe that). From those who claim they never think of seismic danger, only 3% are of the opinion that it will happen soon, most of them arguing that it will be some years from now (22%), or that it will never happen (35%).

The degree of possibility for an earthquake to happen in everyday life is closely related to the fear that their home will be harmed, to the desire to move in a more secure area, and to the measure by which people think they will be helped or be able to recover from the losses. All the results obtained on these aspects from the 2004 survey matches the findings from 1997.

The perception of seismic danger is closely connected to the desire to leave for a safe area ($\chi^2(22) = 40.8$, $p < 0.009$). More than 30% of those living with an earthquake fear would move to a safer area, to the seaside, to the mountains, or to an area with no blocks of flats. They account for only 9.5% of the interviewed persons, while 89% of those who claim to pay no attention whatsoever to earthquakes state they would not consider moving out of the city.

When correlating the perception of seismic risk with the motivation for living in a particular area, the differences between the empiric frequencies and the expected ones indicate a close connection between the two variables ($\chi^2(20) = 39.8$, $p < 0.005$). This correlation points to the increasing acknowledgment of seismic danger in the case of growing pressure on the material and objective components of the individual's options. When the social actors are left with few alternatives, they must accept, due to their socioeconomic level, a particular dwelling situation; consequently, the seismic danger perception grows acute, escalating into a permanent fear. This tendency could be clearly seen in the evaluation of the sample from the old historical center.

A high perceptual independence toward the danger of earthquakes taking place is registered when social actors may choose the residential area according to their own preferences or if they have grown fond of a particular area.

Those who perceive large seismic risk were generally forced to live in a particular area, having no possibility to choose residency (the maximum frequency of the answer: "I could only afford to buy here, where it is cheaper"). In the category of those who hardly perceive seismic risk, the most frequent answers indicate a certain affective link with the residential area ("I was born here") or certain facilities and benefits it offers: ("it is an accessible area," "it has a lot of vegetation," "I like it because . . ."). For those who partly pay attention to seismic risk, the residential area complies with the necessities for one's job, with no powerful affective link.

The extent to which the perception of seismic risk is related to the freedom of choice for a particular residential area was associated with the degree to which subjects believe they will suffer from a future earthquake ($\chi^2(22) = 40.4$, $p < 0.01$). In our sample, approximately 28% consider their household will be severely affected, while 50% think the loss will be minimal or that they will not be affected (19%). This is an important aspect when testing the first level of social vulnerability, defined as the ability of an individual within a household to recover from a natural hazard impact, relating to personal attributes (Granger & Hayne, 2001; Dwyer *et al.*, 2004). The CART decision-tree analyses applied by Dwyer *et al.* (2004) show that the hazard indicator "Residence Damage" is the second most important discriminator for vulnerability to natural hazards, after "Injuries."

In the sample from Bucharest, those constantly concerned with this problem and who are forced to live in a particular residential area consider the losses will be greater (42.8% of the subjects living with the constant fear of an earthquake). Those who scarcely perceive the seismic risk and who are fond of the residential place often answered, "I don't think my household will be affected" or "damage will be minimum" (more than 26% of those who pay no attention to seismic risk).

At the same time, the fear of great loss is related to the extent to which subjects believe they will be able to manage the disaster or, conversely, that they will not be able to recover from the loss ($\chi^2(9) = 20.7$, $p < 0.01$). Those who are afraid the damage will be considerable cannot afford to replace damaged belongings and believe they will recover few things (48%) or even nothing (41%).

People's distrust in the possibility of recovering their goods is closely connected to the options they think they have to ask for and get help ($\chi^2(12) = 39.4$, $p < 0.001$). In the sample, 26% believe that their families would support them; they are also confident that they would be able to partially or fully recover their goods (60%). They would ask especially for material items, but also for moral support. More than 38% of the interviewed subjects believed they would receive no help. Only 15% expected the Romanian government or local administration to help them. Over 63% of those who doubted that they would ever get any help also considered that they would never recover the loss.

If a calamity were to strike, only 26% of the interviewed subjects considered that they would be able to restore their household. Most of them (39%) think that it would take more than a year. The subjects who have no proper resources based this on support from their families (10%). Most of the subjects who could not independently recover from the disaster were well aware of the difficulty to overcome the crisis (17%), approximately 4% expecting God to help them. The analyses indicated that the majority of the subjects who live in constant fear of seismic danger think it will be very difficult to get over such a disaster (54.5%).

With respect to the independent variables related to residence type (living alone, as a couple, single parents with dependents, etc.) and property form, the differences of deviations of empirical values from the theoretical distribution are not significant for the intended correlation, which indicates that the issue goes well beyond those criteria, and are in accordance with the results of 1997 (Armaş & Neacşu, 2003).

Although household type provides an insight into the physical safety of people, for example, an earthquake will be more of a risk to those living in a multistory, old building than to those living in a house, there was no statistical significant link proved between housing and earthquake risk perception. A significant level of correlation was tested when people had knowledge about a high vulnerability of the building they live in ($\chi^2(4) = 11.3, p < 0.023$).

6. CONCLUSIONS

The main conclusion that emerges from this study is that the population living in Bucharest is not prepared to cope with the consequences of a major earthquake, particularly from a material point of view. This is also emphasized by the high percentage of those who deny that such an event might occur. Perception of seismic risk among the potentially affected population depends on demographic (sex, age, education, etc.) and social-economic factors, which offer a particular freedom of choice for the social actor.

Compared to the study in 1977, the study that was conducted in 2004 highlights constants that influence the danger perception and new tendencies emerging from the continuous degradation of the living standard as a result of the instability of the economic situation for most of the population with average incomes. The study also proves that there still is a significant difference in perceiving seismic risk according to gender. Under increasing economic strain, this difference in seismic risk perception according to gender disappears, making place for a constant concern with the hazard.

Unlike in 1997, there is, however, a significant difference in age groups with respect to the way people relate to seismic danger. The decreasing life standard for the majority of the city's population is mirrored by a growing fear of seismic danger, especially for elderly people who are the most vulnerable to social and natural instabilities. Within this age category, the female population with average or poor education is more vulnerable. Feelings toward the residential area is another factor of statistical significance for the population's danger perception. A strong affective bond offers a feeling of safety and leads to neglect and even total denial of the danger.

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