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Lebanon is characterized by strong but rare earthquakes. Beirut's important urban density results in a high level of human vulnerability. A questionnaire survey performed on a sample of 176 people allows better understanding of the individual vulnerability of residents facing earthquakes. The survey questions the perceptions and the knowledge about seismic hazards, the behaviors in case of an earthquake and the protection strategies. The results show a good perception of the seismic threat but dispersed knowledge. The residents know how efficient earthquake-resistant construction is, expect more information but remain skeptical about institutions. Among the variables explaining this, education has a key role, unlike classical factors such as gender, the presence of children or the lessons drawn from past experience. A synthetic index built from the answers to the questionnaire confirms the role of education.

Keywords: risk perception, seismic risk, individual social vulnerability

Introduction

The LIBRIS multidisciplinary project gathers French and Lebanese researchers to assess Lebanon's seismic hazards (historical seismicity, probabilistic assessment of hazards, assessment of local site effects) and the vulnerability in Beirut (buildings, management of the built heritage and perception) and to reproduce a crisis through agent-based modeling (Truong et al. 2013). It includes an assessment of the social vulnerability through a questionnaire on seismic risk perception among a sample of Beirut residents. The moderate seismicity of Lebanon encourages surveys on social vulnerability. Yet the frequency of earthquakes is too low to create a constant institutional vigilance leading to prevention policies or individual preparation. However part of the population has been affected by tremors and benefits from an experience in the field of behaviors in case of an earthquake (evacuation towards an open space, panic, etc.). In order to improve population awareness and preparation, it is preferable to identify the factors of individual social vulnerability. Yet knowing the vulnerability according to social groups enables the levers of action to be adjusted to specific populations. The first part of the article positions the survey in a wider scientific context (state of the art). The second part describes the site of Beirut and states the objectives of the research. The third part defines the methodology. The fourth part presents the results which are then discussed in a fifth and final part.

State of the art

Since the 1990s – often at the request of governmental or international institutions – multiple definitions have conveyed the concerns from the disciplines eager to shed light on collective decisions in order to reduce natural hazards. Some theoretical analyses and practical needs lay the foundations for our research on vulnerability:

- The analysis of social vulnerability shows the state of a society facing a hazard;
- The absence of a unique methodology calls for indicators and assessment criteria;
- The multitude of scales, the diversity of the disciplines concerned, and the diversity of subjects studied are prompting methodological abundance.

Among the disciplines involved in this survey lies ambivalence with regard to the term vulnerability. Vulnerability is commonly assimilated to a weakness or a deficiency of social groups facing hazards. Geography, psychosociology, economy, engineering, etc. address the study of vulnerability according to environmental (Cutter, Mitchell, and Scott 2000b), economic (Borrell et al. 2006; Masozera, Bailey, and Kerchner 2007; Benson 2008), social (Cutter, Mitchell, and Scott 2000a; Cutter 1996; Buckle, Marsh, and Smale 2000; Cutter, Boruff, and Shirley 2003; Tapsell et al. 2002), demographic (Tapsell et al. 2002; Eakin and Bojorquez-Tapia 2007), financial (Galobardes 2006), etc., dimensions.

There is no consensual definition of social vulnerability (Cutter, Boruff, and Shirley 2003). But all studies on vulnerability involve considering its elements. The methodology of the survey and its assessment result from this analysis. Being multidimensional, social vulnerability cannot be strictly reduced to one sole variable (Cutter and Finch 2008). Which vulnerability factors should then be considered? In their works, Zou and Wei counted 361 different factors (Zou and Wei 2010), of which 287 have a socioeconomic character and 74 relate to risk management. Among the factors identified, one can mention the perception of past experience, individual behaviors, information, knowledge, preparation and the perception of institutions.

In this vast panorama, our team chose to analyze several simple factors in relation to the seismic theme and the scarcity of statistical data available on the Beirut population. Yet the absence of a population census leaves us without any reliable information or any basis for a statistical extrapolation of the results. As a consequence and with this in mind, we think that several elements make up an individual's vulnerability to earthquakes: 1) perception and knowledge of the risk 2) knowledge of the individual behaviors for safeguarding in a crisis situation and 3) personal strategies of protection.

Beirut facing the seismic risk

Context of the Study

The survey on individual social vulnerability concerns inner Beirut and more precisely the districts of Sanayeh and Sioufi (Figure 1). Historically, the city of Beirut was very badly damaged or even totally destroyed by several earthquakes and tsunamis in 551, 1202, 1759, and 1837 (Daeron et al. 2007). The city of Beirut is regularly shaken: for example, the seismic crises of Damour between 2006 and 2008, Sour in 2008 or more recently an M4.2 earthquake in May 2014. An earthquake with a high magnitude (greater than 7) is feasible (Harajli, Sadek, and Asbahan 2002). Since the last deadly earthquake in 1956 (Ms5.1), several generations' lack of experience and the development of urbanization have relativized the behaviors that were adopted at that time: in an urban fabric that has become very dense, it is now difficult to walk to an open space.

The geographical location enhances vulnerability. The isolation of the city on a hill is marked by the coastline and the coast road which leave people without any escape to the sea in case of a tsunami (Figure 1). The topography of Beirut's rectangular peninsula naturally hinders evacuations: the city is very densely urbanized, marked by several hills and valleys, bordered by the sea on two sides and by the cliffs and the river on the other side (Adjizian-Gérard et al. 2013). In the East, the foothills of Mount Lebanon represent a geographical frontier with the Beqaa valley. As a consequence, it is vital to know how to protect oneself *in situ* and possibly find resources and bring help to the neighborhood of the district.

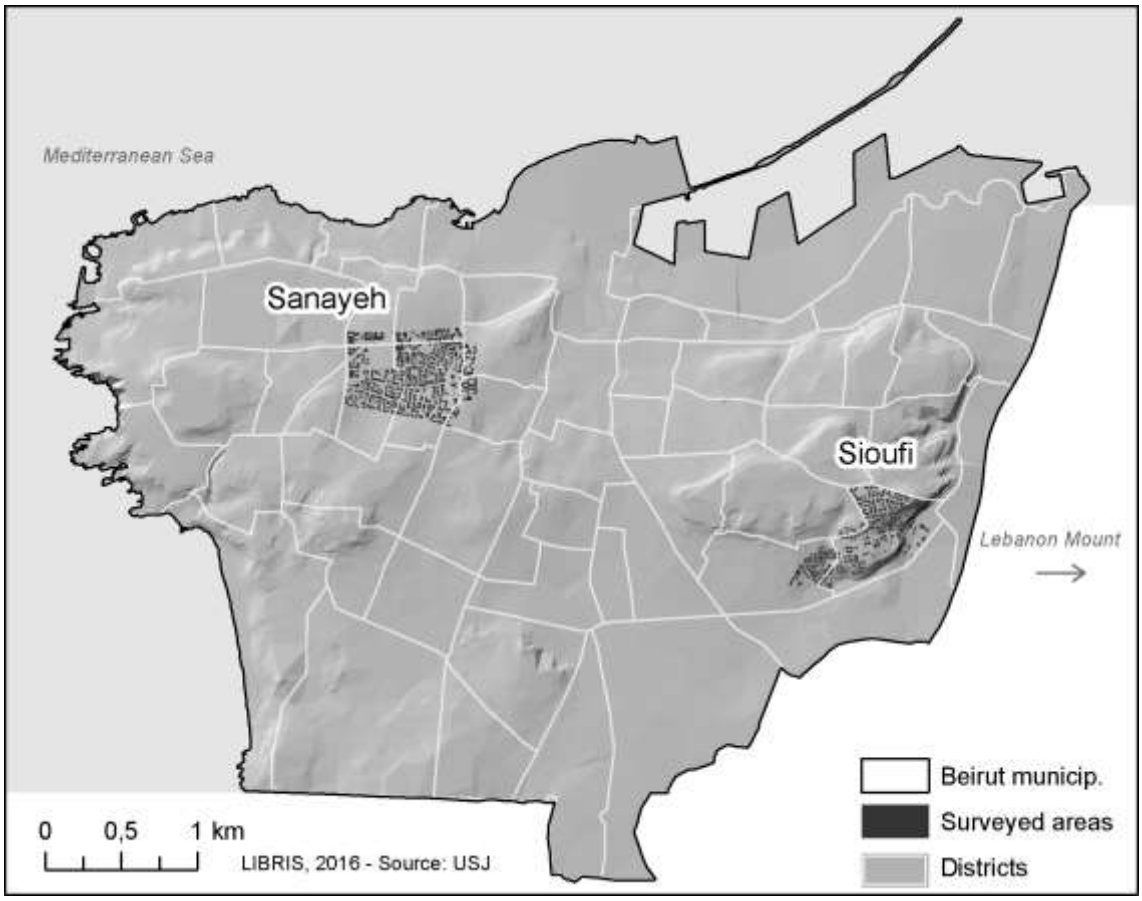

Figure 1. Geographical context of Beirut and the two districts surveyed.

As there has been no population census since 1932, the population of the city of Beirut can hardly be assessed. According to Géopolis (Verdeil and Dewailly 2016), based on buildings gathering, the Beirut urban area had almost 2 million residents in 2010. Marked by a high urbanization rate, the population is then massed into a city with very heterogeneous built-up areas where towers with several dozen floors border on ancient houses that are quite often badly maintained and sometimes restored. As a result, urbanization is extremely dense and the vulnerability of built-up areas very heterogeneous (Pico 2006). In those areas, daily car traffic is difficult.

From a cultural point of view the Lebanese population is officially composed of 18 different religious communities (12 Christian, 5 Muslim and 1 Jewish). The communities live together in a sometimes difficult climate and the territory is marked by significant sociospatial segregation. Yet the community identity of a district is easily identifiable.

Finally the political context may be significant: the city was marked by the 1975-1990 civil war. Those episodes of fighting weakened the city buildings and the ruins of the bombings are still visible.

Objectives

In order to understand the specificities of the vulnerability to earthquakes of Beirut's residents, we focused our analysis on the cognitive representations of the hazards, the communication and training media, the confidence in buildings and people's behaviors when facing an earthquake.

More particularly we wished to identify:

(1) The cognitive representations of the hazards, the level of knowledge, the perception of the seismic risk;
(2) The behaviors, reactions and mobilities (real or supposed) of people during the tremors: are they guided by certain social characteristics? Does Beirut's urban morphology modify the mobilities?
(3) Communication and training media: is the learning process driven by experience (of earthquakes, of bombings), institutional information (political, religious authorities, schools, etc.) or is it a more informal process (family, neighbor networks, etc.)? Do Beirut's residents trust information distributors?
(4) The individual strategies adopted (earthquake already experienced) or planned (no previous earthquake experience) to protect and inform oneself: are the strategies linked with social factors? With sociodemographic variables? Do people think that the building they live in would resist in case of an earthquake?

Political instability, the civil war and bombings can strongly impact these elements of vulnerability, notably in the relationship with authorities. A majority of this population was exposed to bombings during the civil war or more recently during Israel's invasion in 2006. Used to protecting itself from bombings, the population can show particular safety behaviors that however can contradict the actions of seismic protection.

Methodology

Survey

To assess the perception of hazards, the knowledge and the protection strategies of Beirut's population, a survey was carried out between July 2010 and December 2011. This duration can be explained by political instability that brought about difficulties in recruiting pollsters and also mistrust from the population. Due to the lack of an available census, the sample did not target statistical representativity but rather diversity in residential and social situations. The sampling method could not be based on socio-demographic characteristics either. The districts of Sioufi, mostly Christian, and of Sanayeh, mostly Muslim, are culturally homogeneous but socially heterogeneous. The sample was established from a stratification of buildings (Zaarour et al. 2001), according to the height of buildings (Pico 2006) (Table 1), supposed to give a rough indication of its physical vulnerability. One adult selected at random was interviewed using a questionnaire in each building, in total 88 in each district.

Table 1. Number of floors of the buildings surveyed in Sioufi and Sanayeh.

Number of floors	**Sioufi**	**Sanayeh**
	%	**%**
1 to 2	10.7	9.6
3 to 4	22.2	18.4
5 to 8	30.5	25.6
9 to 12	25.3	23.2
13 and more	11.2	27.2

Consistent with previous works, the questionnaire keeps a methodological line –

analyzing the perception of hazards, the attitudes and behaviors when faced with the hazards. The model considering the adoption of protection strategies developed by Rippetoe and Rogers (1987) in the field of health (tobacco addiction) and then adapted to the situations of exposure to volcanic (de Vanssay and Colbeau-Justin 1999), seismic (Ministère en charge du Développement Durable and BRGM 2008), hurricane (Sarant 2004) or tsunami hazards (Scheer et al. 2010) gives structure to the questionnaire.

5 themes bring the 67 questions together:

(1) Perception and knowledge of seismic hazards: do you think that Beirut can endure a strong earthquake? What could be the consequences? What is the origin of earthquakes? Can we forecast earthquakes?
(2) Behaviors adopted and to be adopted: have you ever experienced an earthquake? What did you do at the very moment the tremors occurred? Have you experienced bombings? What can you do to protect yourself during an earthquake?
(3) Protection strategies: do you think you can protect yourself from earthquakes? Do you wish to participate in meetings with neighbors and with an expert to get prepared? What would be your priority to protect yourself and your close family and friends?
(4) Information sources and confidence in institutions: usually who informs you on the threatening hazards? How do you wish to get prepared and informed about an earthquake? Do you think that the authorities care about earthquakes? Do you trust what the government, civil defense, the armed forces, the scientists, etc. say?
(5) Sociodemographic features end the questionnaire: age, gender, number of children in the household, real estate status, community membership, studies pursued, profession, and duration of residence.

The questionnaire was tested among 30 people following a little tremor in South Lebanon.

Analysis

The answers were processed using the Sphinx© software with a univariate and bivariate analysis. The results' significance was tested by means of a chi-squared test. A multivariate analysis (factorial analysis of multiple correspondences) was performed unsuccessfully due to too high dispersion of the profiles. Besides this classical statistical processing, while relying on previous works (Glatron and Beck 2008; Beck et al. 2013), we propose a methodology for the construction of an individual index of social vulnerability from the answers to 14 questions of the survey. The objective is to obtain an overall view of the results while considering each question as part of the explanation for the person's vulnerability.

Classically the indices of social vulnerability result from a spatial multiple-criteria analysis, locally mapped according to sociodemographic criteria from national statistical databases (level of income, age, type of housing, unemployment rate, etc.) (Cutter, Boruff, and Shirley 2003; Fekete 2009; Armas 2012). As underlined by Kuhlicke et al. (2011), these indices are rather poverty indices and tend to stigmatize certain social groups (the elderly, women, the poor).

As already mentioned, due to the lack of a population census in Lebanon, the methods based on spatial indices could not be implemented in the framework of our survey. This is why – in line with our perception of vulnerability (see. § State of the Art) - we focused on the questions relating to the perception and the knowledge of hazards, the knowledge of behaviors and the individual strategies of protection.

A score was given to every answer of the 14 significant questions to express a person's vulnerability. For example, answering the question 'Do you think that Beirut can experience a major earthquake?', a 'no' gave a high score (2) and a 'yes' a low score (-2).

A positive value corresponded to a strong individual vulnerability. The minimum (-2) and maximum (2) values given were identical for each question to prevent any artificial imbalance. The sociodemographic variables were not integrated within the index calculation. The index was calculated for each person interviewed and corresponded to the total of the 14 scores. A verification by means of very little or highly vulnerable individual archetypes validated the scale that was established. The theoretical maximum was then 28, the theoretical minimum was -28.

To simplify the interpretation, the index was transposed on a 0 to 1 scale by using the following formula (Eq1):

$$y = (28 + x)/56 \quad (1)$$

where *y* is the new value for the index (0 to 1 scale) and *x* the value of the index on the -28 to 28 scale.

Results

Characteristics of the respondents

Composed of 176 people, the sample is well-balanced in terms of gender and age (Table 2). More inclined to answer a questionnaire, the respondents who are more qualified are slightly over-represented. Besides religious belief (95% of Sioufi interviewees are Christians, 89% of the respondents in Sanayeh are Muslims), the samples in both districts are comparable.

Table 2. Characteristics of the sample interviewed. The totals differing from 176 correspond to no-answers to some questions.

	Sioufi		**Sanayeh**		**Total**
	N	**%**	**N**	**%**	**N**
Gender					
Man	42	58	49	56	91
Woman	46	52	39	44	85
Age group					
< 40 years	37	43	34	41	71
40-60 years	25	29	31	38	56
> 60 years	24	28	17	21	41
Education					
Primary educ./Out-of-school	7	8	9	10	16
Secondary education	40	47	41	47	81
Higher education	38	45	38	43	76

The length of residence in the building is an important criterion to understand the way in which the earthquake was possibly experienced. It is largely greater than 20 years (53%). This shows stable residential roots, a good knowledge of the building and a good integration within the neighborhood. In a city marked by the destructions of the civil war and then by the massive transformations of buildings, this emphasizes that the stability of housing prevails and is reinforced by a family-type real estate and the status of 'old cheap rents' that encourage people not to move.

Finally, the experience of bombings may not be used as an explanatory variable as 91% of the people interviewed had to deal with some bombings. Occasionally the speech used shows that bombings and earthquakes are being equated (‘go to the cellar’ to get protected) or shows some similarities in wording (‘to hide’).

Perception and knowledge of the seismic hazard

A majority of the interviewees (59%) think that Beirut can endure a major seism. This spontaneous answer is important because it opens the questionnaire and so comes before any interactive argument is developed with the interviewer. This majority even reaches two thirds in Sioufi (66% vs. 52% in Sanayeh) where the seismic hazard is a natural concern. The scope of the phenomenon is well-identified because the dominant representation of the consequences of an earthquake in Beirut is rational (34%: ‘damage, destructions, heavy consequences, deaths, according to the magnitude’), followed by a pessimistic representation (11%: ‘total catastrophic disaster, destruction of the whole city’).

The survey also shows the influence of education on knowledge and perception (Figure 2): the higher the educational level, the more people think a major earthquake is possible. In this way 69% of under- and postgraduates think an earthquake is likely vs. 57% of the interviewees who have graduated high school and 25% with a primary education or no education at all. Similarly the proportion of people who have no opinion decreases according to the level of education: 31% for the primary/no school level, 15% for the secondary level and 15% for the under- and postgraduate level (average: 17%).

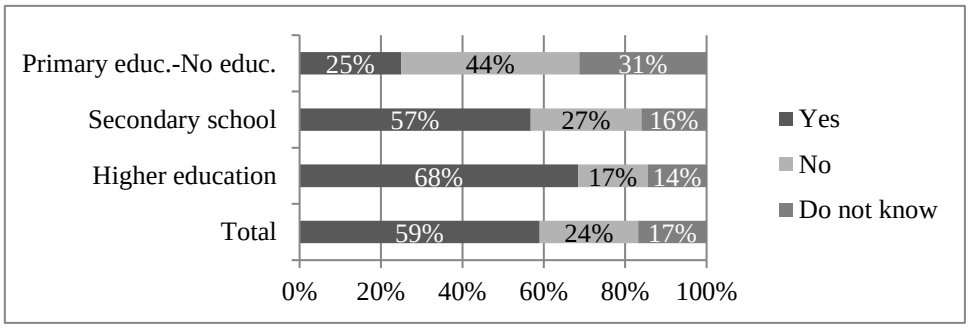

Figure 2. Likelihood of a major earthquake in Beirut according to the educational level of the interviewees. Answers to the question ‘do you think that Beirut may one day experience a major earthquake?’, p = 2.7%; chi2 = 11.00; ddl = 4; the correlation is statistically significant.

The interpretation of the origin of earthquakes varies within the population and guides the projection of the likelihood of an earthquake in Beirut. For 67% of the sample, the origin of earthquakes is tectonic. More than a quarter of the sample (26.7%) thinks the origin is divine. There is also a relation between the supposed origin and the likelihood of a major earthquake in Beirut (Figure 3).

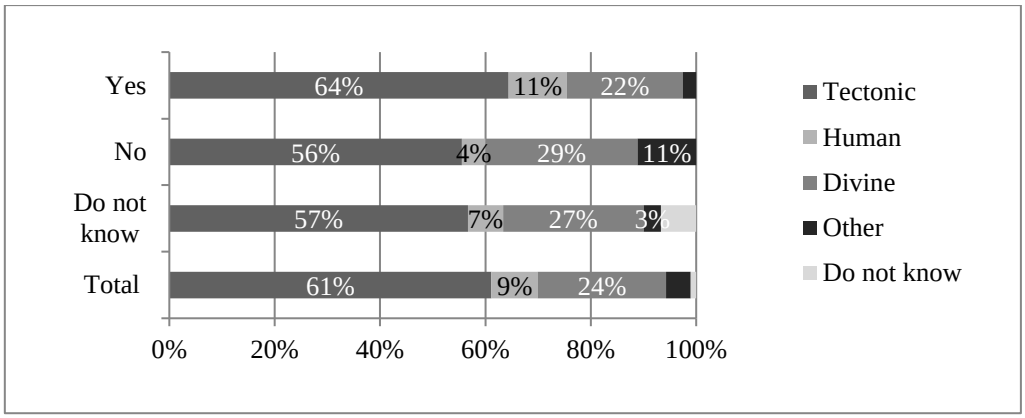

Figure 3. Cross-tabulation between the supposed origin of earthquakes and the likelihood of a major earthquake in Beirut. Answers to the questions 'In your mind what is the origin of earthquakes?' and 'do you think that Beirut could one day experience a major earthquake?'. p = 1.6%; chi2 = 18.79; ddl = 8; the correlation is statistically significant.

Those who consider an earthquake is likely to occur are more inclined to mention a tectonic origin (66.4% against 55.6%). On the contrary, a higher proportion of people who think that an earthquake is unlikely to happen mention a divine origin. The educational background also influences the way the origin of earthquakes is defined. Yet the higher the educational level, the greater the number of explanations based on tectonics and the lower the number of those based on a divine origin.

Behaviors adopted and to be adopted in the situation of a seismic crisis

Ignorance of protection methods during a tremor increases individual vulnerability. The question 'What should you do to protect yourself during an earthquake?' brings about contrasted answers: 39.8% mention a protection method outside the buildings (walk out of the house, flee, walk away from buildings, seek open spaces); 34.1% look for protection *in situ*, in the house (find shelter under a table, stairs, a corner, near a pole, etc.); 26.7 % mention an inadequate protection method and 9.1% do not know what to do. However experience influences the idea of protection: those who have experienced a tremor prefer to seek protection *in situ* (32%; a little more than the 26% without any experience).

78% of the sample declare they have experienced an earthquake, sometimes the same one: the 1956 earthquake (M=5.1, 148 dead; mentioned by 16% of the interviewees) and the 1997 one (M=5, around fifty buildings damaged in Beirut; 46%). Among those people 84% immediately recognized an earthquake. This illustrates the ability to identify the phenomenon.

The intensity of the tremor guides behaviors. People are more likely to walk out of the buildings when the tremor is strongly felt (25% against 7% for small tremors; Figure 4). The proportion of people having no particular reaction increases when the tremors are faintly felt (50% against 18% for strongly felt tremors). Except for people who freeze, mobility (possibly dangerous) is a dominant feature during very strongly felt tremors. The greater the intensity, the more people explain that they tried to get out and the less they mention that they were inactive or immobile (because they froze) and the more they declare that they got protected.

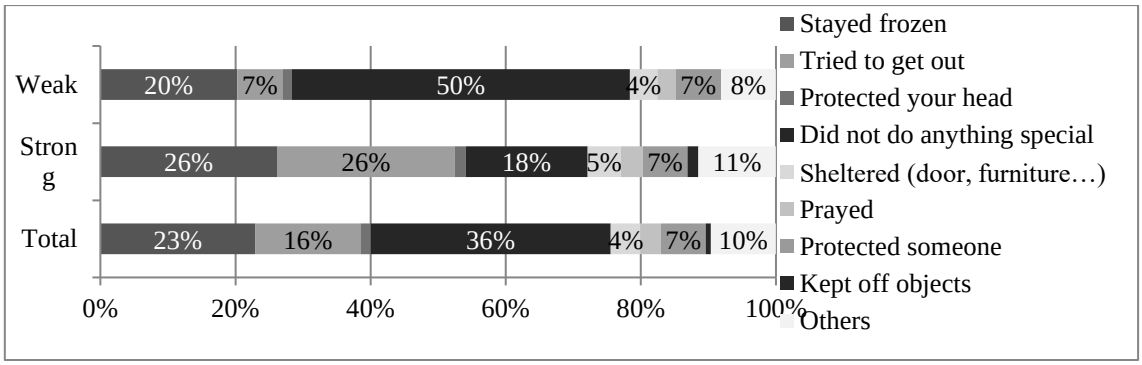

Figure 4. Reaction chosen during the earthquake according to the intensity felt during the tremor. Answers to the questions 'What did you do at the very moment of the tremors? Give one answer only' and 'Those tremors felt: weak, moderate, strong, very strong?' (answers grouped together into two levels). P = 1.0%; chi2 = 20.00; ddl = 8; the correlation is statistically significant.

After a strong tremor, people are more likely to walk out of the buildings (12% against 0% for weak tremors; Figure 5). For a weak tremor, 78% of the interviewees started a normal activity again. Here again the intensity of the tremor felt pushes people into staying immobile (weak tremor) or on the contrary into moving (strong tremor).

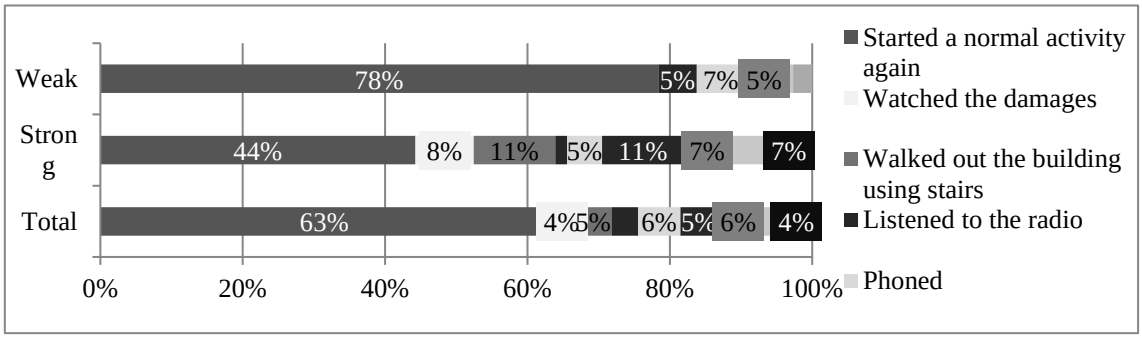

Figure 5. Reaction chosen after the earthquake according to the intensity felt during the tremor. Answers to the questions 'What did you do just after the tremors? Choose only one answer' and 'Those tremors seemed: weak, moderate, strong, very strong?' (answers grouped together into two levels). P = <0.1%; chi2 = 33.33; ddl = 8; the correlation is statistically highly significant.

The way the tremor was felt also modifies the specific mobility: a strong tremor (leading to an evacuation) pushes people into getting to a certain place (39% against 11% in the case of a weak tremor; Figure 6). For only 30% of the interviewees the destination was safe (open space). When trying to join somebody most people gave priority to the family (8 in 10 people).

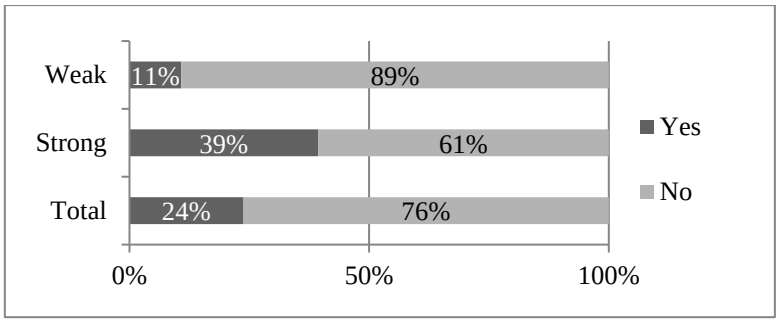

Figure 6. People's mobility behaviors according to the intensity felt during the tremor. Answers to the questions 'Did you seek to get to a certain place?' and 'Those tremors seemed: weak, moderate, strong, very strong?' (answers grouped together into two levels). P = <0.1%; chi2 = 15.05; ddl = 1; the correlation is statistically highly significant.

Protection strategies

Preparation determines the degree of individual vulnerability. Either individuals gather close personal or collective resources (family network, neighbors), or they forfeit their responsibility by transferring the protection role to other actors, often institutional (authorities, rescue services, scientific community). The knowledge of protection solutions needs to be identified beforehand. In Beirut a low majority (55%) think it is possible to protect oneself against an earthquake, 9% remain indecisive. This knowledge increases with the level of education, even if the relation between both variables is statistically hardly significant: people with hardly any qualifications are more likely to think that protection is impossible (44%) and are ignorant of this possibility (19%). Conversely, people with the highest level qualifications are more likely to think that protection is possible (55%) and are less undecided (4%; Figure 7). This confirms that education raises the awareness of hazards.

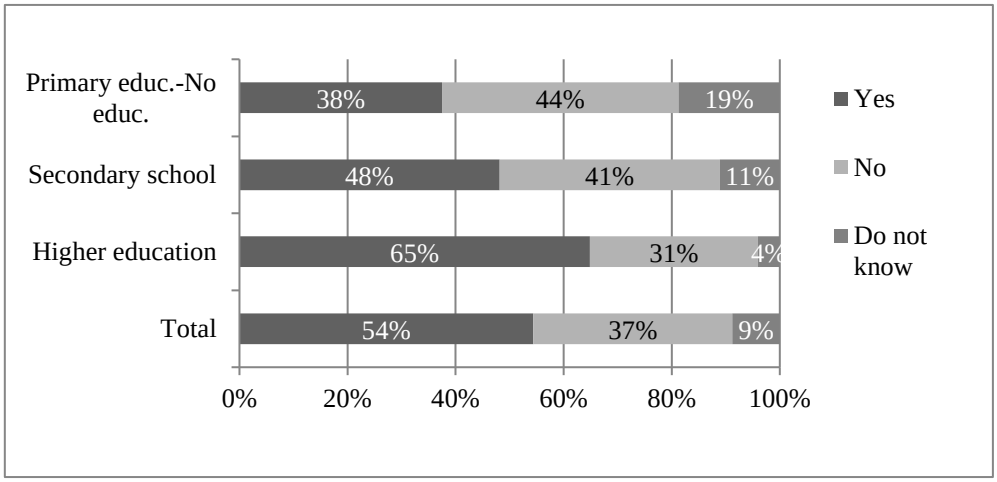

Figure 7. 'Do you think we can protect ourselves against earthquakes?'. Distribution of answers according to the level of education. P = 8.1%; chi2 = 8.32; ddl = 4; the correlation is statistically hardly significant.

Then when people are asked about the means of protection against earthquakes, the main answer concerns the buildings that – they hope –comply with building codes or more

generally can withstand tremors (Table 3). The knowledge of how to behave during an earthquake is mentioned second but individual preparation (setting up a family organization plan or an emergency kit, etc.) is not mentioned. The population seems to be awaiting solutions: information, construction of open spaces, and adoption of adequate building codes.

Table 3. Knowledge of the protection strategies against earthquakes. Answers to the question 'If yes, how?' following 'Do you think that we can protect ourselves against earthquakes?'.

Protection strategy	**N**	**%**
Resistant buildings	46	37
Adapted individual behaviors when the earthquake occurs	36	29
Population awareness	15	12
Others (forecast, open spaces, etc.)	15	12
Do not know	11	9
Total	**123**	**100**

This apathy is mentioned again when answering the question 'Since this earthquake occurred, have you done anything to be better prepared?' Yet if experience can encourage preparation only 4% of people answered yes. The low intensity of the tremors can explain this lack of individual involvement.

This general framework logically influences individual strategies. The individual priority shows the same results: first living in a safe building (40%; Table 4), then knowing some instructions (19%). A few people mention knowledge about the phenomenon, the organization between neighbors or within the family, the preparation of an emergency kit (respectively 7%, 5%, 4% and 4%). The experience of an earthquake, the presence of children, and the area of residence or gender do not influence the results in a significant manner.

Table 4. Individual protection priorities against earthquakes. Answers to the question 'What would be your protection priority, for you and your close family members? Give only one answer'.

Primary protection strategy	**N**	**%**
Living in a safe building	71	40
Knowing the instructions	33	19
Others	18	10
Getting informed about earthquakes	13	7
Following a first aid training course	12	7
Getting organized with neighbors and close family members	8	5
Arranging the accommodation	7	4
Preparing an emergency kit	7	4
None	7	4
Total	**176**	**100**

Local preparation for a seismic event strongly involves direct knowledge of the neighborhood to understand the threats relating to constructions, the specific vulnerabilities like schools or old-aged people and the potential local resources (rescue equipment, supplies, skills, etc.). However, only one third of the sample wishes to participate in seismic preparation meetings in the neighborhood along with an expert (Figure 8). The educational level is again a decisive factor. Yet education involves getting trained and informed.

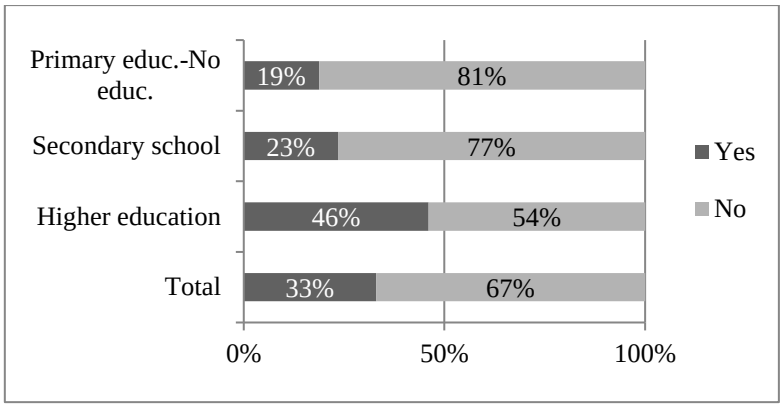

Figure 8. Desire to have a meeting according to the educational level. Answers to the question 'Do you wish to participate in meetings between neighbors along with an expert to get prepared in case of an earthquake?'. chi2 = 10.67, ddl = 2. 1-p = 99.52; the correlation is statistically highly significant.

The interviewees mostly trust the institutions without getting involved at local level. However the majority (86%) considers that the authorities do not deal with the seismic hazard.

Information sources and institutional trust

Raising awareness, informing and communicating during the crisis reduce seismic vulnerability. But the same media is not necessarily adapted to the whole of the population. It is vital to multiply the information and communication media to raise awareness about the hazard, teach architectural prevention and train people about protection during tremors. Several channels are considered to target information according to the reception possibilities and adapt it to the media favored by the population. Besides the media (press, television, the internet, etc.), institutional communication (scientists, public administrations, rescue services), school and community communication (family, vicinal, religious) are also considered. The aim is also to identify the degree of confidence according to the source of information.

Understanding the usual communication on hazards among Beirut's population makes it possible to target the preventive information on earthquakes. Obviously the journalists are the primary source of information (Table 5). The scientists are also largely mentioned. Then the neighborhood is also a significant source of information for more than a quarter of the interviewees. Finally the security forces (FSI) in Sanayeh (28% in Sanayeh; 22% in Sioufi) and the armed forces in Sioufi (30% in Sioufi; 24% in Sanayeh). The government is sometimes mentioned as a source of information but the city's authorities are almost not mentioned at all by the interviewees, which indicates weak recognition of the role the authorities play against dangers.

Table 5. Usual sources of information on the dangers the interviewees are exposed to. Answers to the question ‘Usually who do you get information on threatening dangers from?’. The sum of percentages is greater than 100% because several answers could be given. Percentage calculation is made with the total number of respondents (N=176).

Usual sources of information on the dangers	**N**	**%**
Journalists	118	67
Government	72	41
Scientists	71	40
Neighbors	50	28
Armed forces	47	27
Domestic security forces	44	25
School	35	20
Others	30	17
City authorities	17	10
Religious authorities	16	9
Total	**176**	

However the sources of information recognized vary according to the level of education. Those with little education favor oral sources: journalists (17%), neighbors (19%), religious authorities and schools; the graduates prefer more coded sources: journalists, scientists and the government (Figure 9). The sources and messages must then adapt to the populations' interpretation abilities that are very much influenced by the educational background. On the other hand, age does not significantly influence the results.

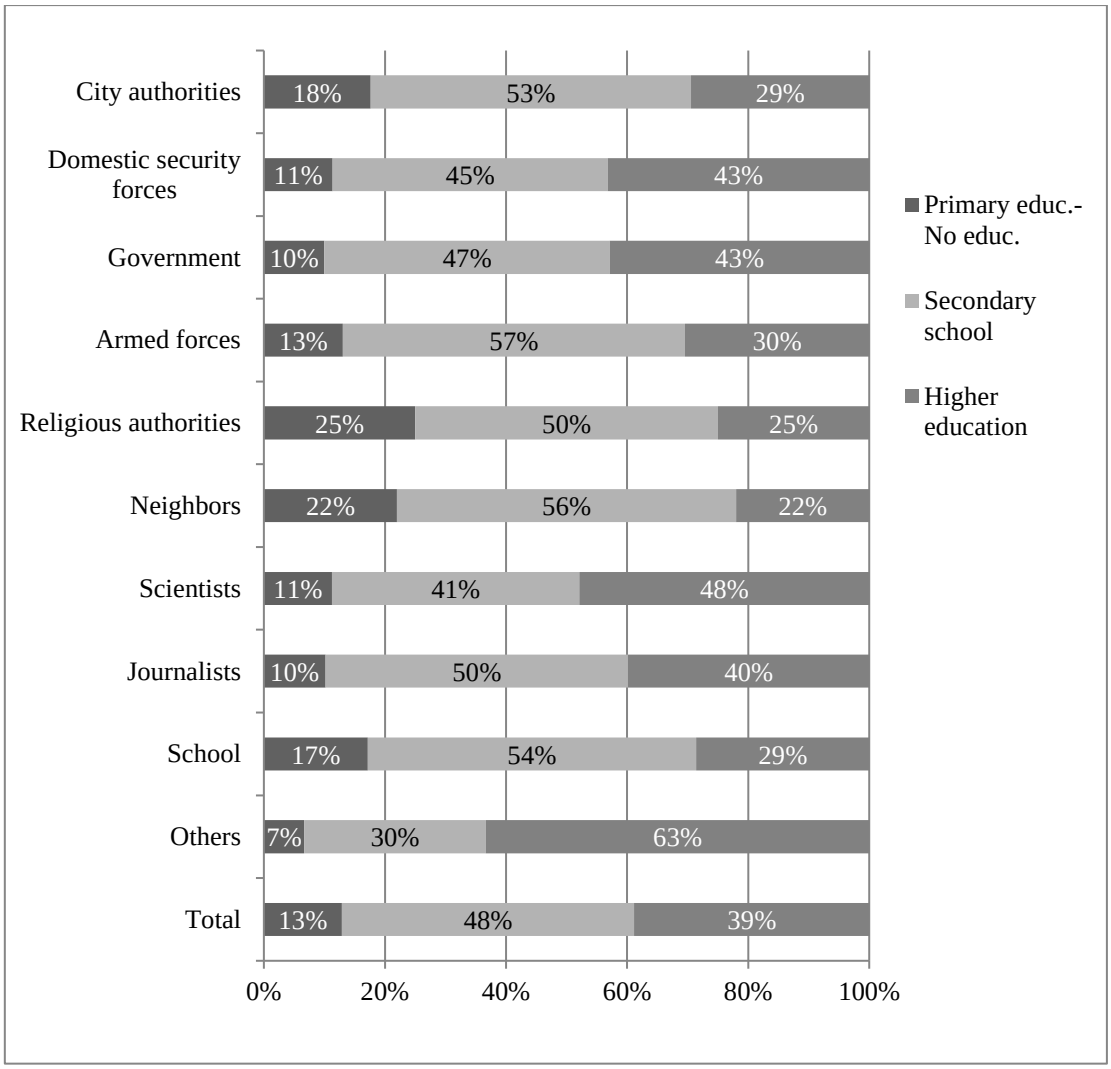

Figure 9. Usual sources of information on dangers according to the level of education. Answers to the question 'Usually who do you get information on threatening dangers from?'. p = 0.3%; chi2 = 38.77; ddl = 18; the correlation is statistically highly significant.

The answers are similar for the institutions communicating in case of a crisis (Table 6): the government largely leads the way, followed by the media and scientists. 6% of the sample did not mention anybody in particular and only 3% did not know what to answer.

Table 6. Source of communication in case of a crisis. Answers to the question 'According to you who must communicate in case of a crisis?'.

Communication in a crisis situation	**N**	**%**
Government	73	42
Media	48	27
Scientists	19	11
Specialists	16	9
Nobody	10	6
Armed and Domestic Security Forces	6	3
City authorities, Mortaz ('Mayor')	5	3
Do not know	5	3
Others	5	3
Red Cross	1	1
Total	**176**	**100**

Concerning information wishes, television remains the reference media (Table 7), but in a greater manner in Sanayeh (69%) than in Sioufi (52%). The recognition of the internet is progressive and equivalent in both districts (13%). The sample prefers classical information media where a source broadcasts a message. The interest for the new information and communication technologies (NICTs) surpasses the interest for participative media where one contributes and shares information. Schools and parents are mentioned marginally among the 'Others' answers.

Table 7. Expected sources of information on hazards. Answers to the question 'How do you possibly want to get prepared and be informed to face a future earthquake?'. The sum of percentages is greater than 100% because several answers could be given. Percentage calculation is made on the total number of respondents (N=176).

Expected sources of information	**N**	**%**
TV shows	110	63
Websites	21	12
Others	20	11
Conferences	12	7
Information brochures	10	6
Press articles	10	6
Exercises	6	3
Radio programs	4	2
SMS	3	2
Permanent information points	2	1
Not interested	1	1
Public poster campaigns	0	-
Discussions with neighbors	0	-
Tweeter	0	-
Total	**176**	

Television is widely mentioned as an expected source of information but in different ways according to education (Figure 10). Low-educated people hardly mention newspapers or brochures (traditional/top-down information media). The graduates mention the internet, text messages and tweets (NICTs) more.

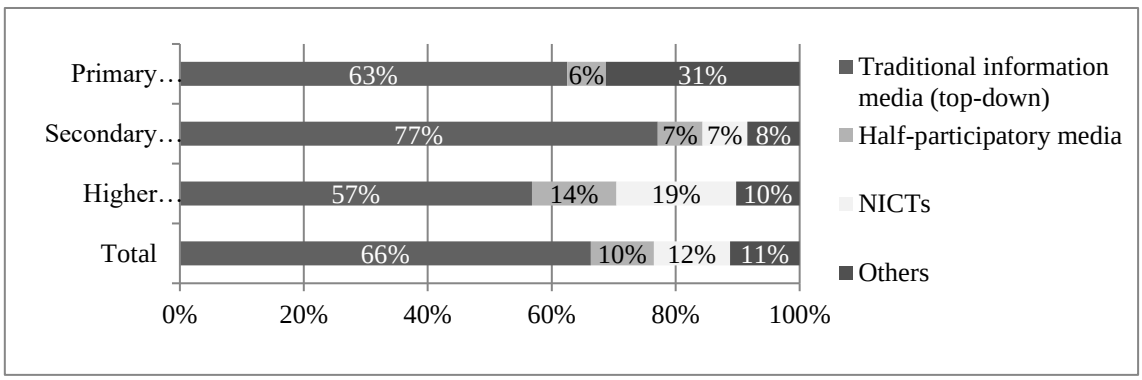

Figure 10. Expected sources of information on hazards according to the level of education. Answers to the question 'How do you possibly wish to get prepared and be informed to face a future earthquake?'. The answers to this question were grouped into four categories; p = 0.5%; chi2 = 18.56; ddl = 6; the correlation is statistically highly significant.

The source of information is often linked to the confidence people have in emitters. As regards confidence in institutional communication, the Armed Forces are in first place ahead of Civil Defense and the scientists. The government and city authorities are the last (Table 8), which confirms the mistrust in the authorities' commitment to the prevention of hazards.

Table 8. Percentage of people trusting every institution mentioned. Answers to the question 'Do you trust what they say...'. The sum of percentages is greater than 100% because several answers could be given. Calculation of percentages is made with the total number of people (N=176).

Institutions	**N**	**%**
Armed Forces	130	74
Civil Defense	128	73
Scientists	122	69
Domestic Security Forces	81	46
Journalists	72	41
Government	43	24
City authorities	38	22
Total	**176**	

Decisive factors of individual social vulnerability

A synthetic index simplifies the interpretation of results to define the factors of individual vulnerability. The average vulnerability index corresponds to the average of indices for several individuals. It is calculated according to age, education, gender sub-groups and to the presence of children and housing status. To compare the results for each statistical method, the average index was subtracted from the index average value (calculated for the whole sample): we then obtain an average deviation for each socially defined sub-group. Those values are drawn on a graph. The sub-groups for which the average deviation is positive are more vulnerable than the average; those whose average deviation is negative are less vulnerable than the average of the sample surveyed.

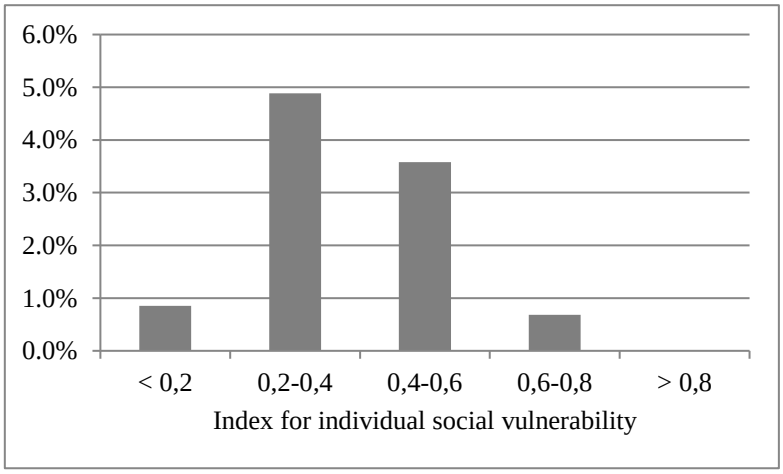

Figure 11. Distribution of the values of the index for individual social vulnerability. Average: 0.39; Max: 0.75; Min: 0.13.

The distribution is asymmetrical to the left from 0.5 (theoretical average of the index) which indicates that the population has an average vulnerability (Figure 11), as the minimum (0.13) and maximum (0.75) values show, as well as the average of the Beirut sample (0.39).

The level of education influences the perception of seismic hazards, the knowledge of protection strategies, the identification of primary protection strategies and the favored information sources. It then seems logical to consider whether education influences individual social vulnerability (Figure 12). There is a highly significant relationship: the higher the level of education, the weaker the vulnerability index. The average deviation reaches 10% for the group of individuals with little or no education, 5% for the postgraduates.

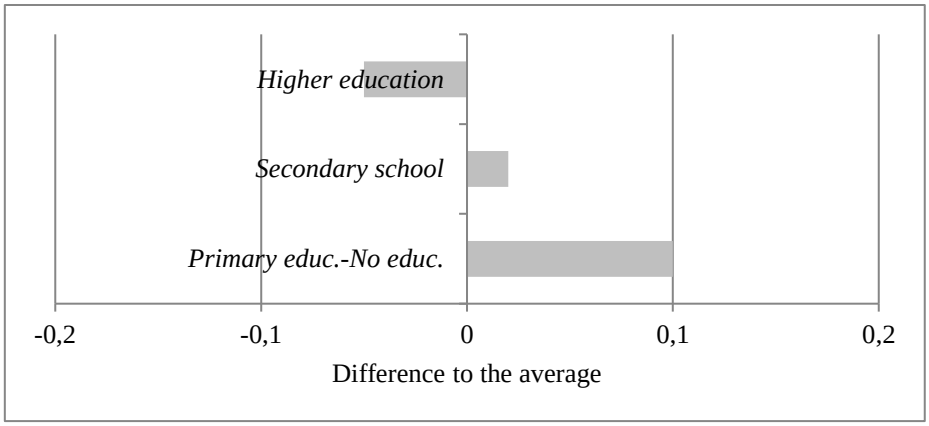

Figure 12. Average deviation of the index of individual vulnerability according to the level of education; average = 0.39; the correlation is statistically highly significant.

The same data processing with the age group shows that the oldest are more vulnerable and the youngest less: there is respectively a +4% and -3% average deviation for the whole sample (Figure 13). This can be explained by more limited access to information on seismic hazards for the oldest, which influences the knowledge of the phenomenon, of the behaviors to be adopted, etc. It should be noted that the oldest people in our sample are also the least educated.

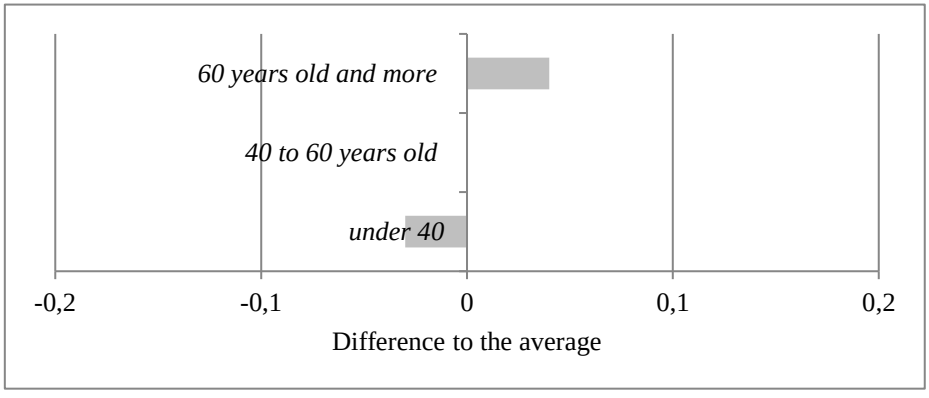

Figure 13. Average deviation of the index of individual vulnerability according to the age group; average = 0.39; the correlation is statistically significant.

The significance tests are nevertheless not conclusive for the sub-groups defined by

gender, housing status and presence of children, which indicates that, in the framework of our Beirut sample and considering methodological specificities for the construction of the index, those sociodemographic variables do not influence individual social vulnerability.

Discussion

As highlighted by other authors (Kuhlicke et al. 2011), the factors explaining vulnerability are not systematically the same from one cultural context to the next. Besides, according to the psychometric paradigm introduced by Fischhoff et al. (1978) and Slovic (1987), culture can strongly modify the perception of seismic hazards and the responsiveness of populations which are two fundamental components of individual vulnerability (Palm 1998). The internal causal attribution makes the subjects responsible for the origin of their actions while they think they can somehow control things. On the contrary, the external causal attribution provides the subjects with external influences on their actions while they think they cannot influence things and attributes repetitions to chance or to other more powerful people.

The perception of seismic hazards as a threat to life in Beirut is widespread. However numerous people feel helpless when it comes to protecting themselves against earthquakes. The external causal attribution dominates and is more marked by a divine or natural destiny. The personal protection abilities are less considered (application of earthquake-resistant building codes, training in protection methods, etc.). However the level of education strongly drives knowledge towards a stronger personal commitment.

The survey reveals disseminated knowledge on seismic hazards, likely to be marked by the memories of major tremors for older people. Besides personal experience, the population is strongly marked by the broadcast of media information in particular TV coverage of distant disasters.

As regards the origin of earthquakes, besides the classical divide between a scientific explanation and a divine origin, a significant proportion (almost 6%) of the population surveyed mentioned both answers. Tekeli-Yesil et al. (2011) came to the same conclusion (18% of the respondents in this last case). This mixed origin can be explained by the fact that the interviewees know the seismic phenomenon is scientifically explained, that it is linked to tectonics, but that a divine origin causes the movement.

The population seems to be awaiting information but is not naturally interested in neighborhood information meetings. The youngest will search for media information (on the internet), possibly influenced by education, information on disasters or even because they felt regular local tremors. To get informed on hazards, the sample turns to journalists in particular the television (this media is also mostly mentioned by the interviewees of the survey by Tekeli-Yesil et al. (2011)), then scientists, then neighbors, then Security Forces, then the government (but not the city authorities or religious institutions). The authorities are generally mistrusted (as in other geographical contexts, like Chile (Bronfman et al. 2016)), especially regarding the way that they take responsibility for managing seismic risk (86% consider that this is not the case). The traditional media channels are favored. Contributing to information is a secondary concern, mostly expressed by the youngest, often more informed and eager to get information from all over the place.

Living in a secure building is the protection strategy the most mentioned as in the survey carried out in Turkey by Tekeli-Yesil et al. (2011), where 67% of the interviewees stated that the building codes should first be implemented. It is interesting to note that, within the Mediterranean context, where the building methods show a certain

homogeneity, this answer comes first in several survey cases while the same question asked in Argentina puts the knowledge of instructions and family preparation first (Trémel 2014).

The protection tactics look rather limited for the time being. Many people do not trust their housing. The population also has doubts about the efficiency of institutions in the field of information and rescue. The previous organization attempts either seem inadequate or very basic, sometimes learnt during the war. People are not indifferent to hazards but they do not know where to start. Moreover they usually doubt that the rescue services are efficient in such a densely built city where undisciplined behaviors are a daily ordeal.

While classical factors (gender, presence of children in the household, etc.) often explain people's commitments, our sample shows that gender, lessons learned from past events or having children do not particularly influence the perception of seismic hazards, the protection strategies and the knowledge of behaviors. More specifically, the experience of an earthquake does not positively influence the knowledge of behaviors to be adopted, as if those who already experienced a tremor knew that they should not overestimate their capacities facing a disaster. In other studies, it has been shown that having experienced more earthquakes leads to a low perception of risk (Tian, Yao, and Jiang 2014).

Table 9 sums up the various cross-tabulations made.

Table 9. Summary of the significance tests performed between various elements of social vulnerability and explanatory factors.

Elements of social vulnerability/explanatory variables	**Age**	**Educ.**	**Experience of an earthquake**	**District (cultural group)**	**Gender**	**Children**	**Intensity of tremors**
Likelihood of an earthquake	*	**	¤	¤	¤	¤	¤
Origin of an earthquake	*	***	¤	**	¤	¤	-
Reaction during an earthquake	-	-	-	-	-	-	**
Reaction after an earthquake	-	-	-	-	-	-	***
Mobility during an earthquake	-	-	-	-	-	-	***
Protection possibilities	***	*	¤	¤	¤	¤	-
Priority preparation strategy	*	**	¤	¤	¤	*	-
Desire to have a meeting	-	***	¤	¤	¤	¤	-
Usual source of information on earthquakes	¤	***	-	*	¤	¤	-
Expected source of information	*	***	¤	**	¤	¤	-

*** very significant; ** significant; * hardly significant; ¤ not significant; - not tested

The various statistical analyses show the influence of education. This assessment agrees with previous work since the level of education was highlighted by several authors as an important factor in the perception and in the choice of protection strategies (Bird and Dominey-Howes 2008; Tekeli-Yesil, Dedeoglu, Braun-Fahrlaender, et al. 2010; Beck et al. 2013). This easily explains the fact that the school is a privileged place where knowledge is handed down regarding the various components of hazards (risks notably) and the existing means to get prepared for such an event – this knowledge then modifies the perception.

Regarding the difference between districts and cultural differences, the denominational ‘community’ specificities are constantly admitted by the Lebanese population and institutions. Our survey focuses on two districts of inner Beirut considered as ‘Christian’ and ‘Muslim’ areas. Even though religious homogeneity is proven in Sioufi, it is less marked in Sanayeh. The religious or scientific interpretations of the seismic risk are not divided according to districts. The more divine interpretation of a seismic origin

in Sanayeh is linked with a lower level of education. Yet education is more important and long-standing in Sioufi and guides the interpretations towards a tectonic origin of earthquakes.

The Beirut survey raises the methodological problem of surveys on the perception of hazards from past events in countries where vulnerability is high but tremors are rare and strong. The scarcity of earthquakes restricts the collection of answers for the same event. However, knowing the behaviors of those populations guides the prevention campaigns according to contexts. Adapting the monitoring protocols (detailed surveys on the internet, etc.) would ease the systematic collection of testimonies.

Finally from an operational point of view, the answers to the questionnaire provide for several lines of thought. First, other authors show that individual preparation is influenced by an adequate awareness of hazards (Tekeli-Yesil et al. 2011) and a good knowledge of the phenomenon (Tekeli-Yesil, Dedeoglu, Tanner, et al. 2010). The institutions can seize upon the seismic question, for example through education. The answers promote an increase in the media channels used to inform the population on the hazards they are subjected to (another suggestion from Tekeli-Yesil et al. (2011)) while preferably targeting the 'less educated' people. Besides, in a context where institutional power is fragile, which slows down the development of massive and countrywide prevention policies, people must act by widely committing to their own security regarding earthquakes. This requires a spontaneous search for information, organization at local level between neighbors or within the family and the preparation of an emergency kit.

Conclusion

In conclusion, the survey carried out here provides new insights into the perception of seismic risk by the inhabitants of Beirut, who seem to have a good knowledge of the risk of an earthquake. The survey provides insight into the determinants of social vulnerability, such as educational attainment and age. Concerning the behavior adopted at the time of an earthquake, one observes a relative immobility, probably due to the weakness of the shocks, but also assumes a misunderstanding of the correct behavior to adopt. The experience of bombing, which encourages contrary behavior (hiding inside), is a hypothesis of explanation. Finally, the unstable political context causes individuals to distrust the authorities, even though they rely on the State to ensure their safety in the face of earthquakes through the application of seismic standards, identified as the priority for protecting oneself. From a methodological point of view, the research presented in this article makes it possible to consolidate the construction of an index of individual social vulnerability, based on cognitive dimensions of vulnerability. Seismic safety in Beirut therefore remains a major challenge for local authorities to minimize the consequences of a future major event.

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