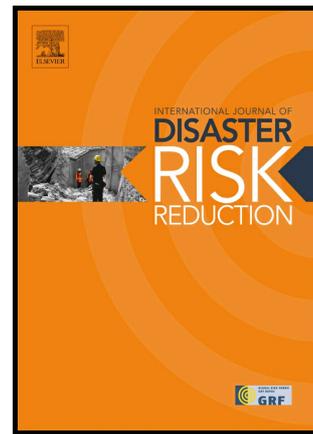


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Assessment of social vulnerability to seismic hazard in Nablus, Palestine

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Abstract

Social vulnerability helps to explain why communities experience the consequences of an extreme event, such as an earthquake, differently, even when they are subjected to similar levels of intensity (ground shaking). The differential impacts of an earthquake can indeed be a consequence of social vulnerability, hence, it is a critical element for fostering mitigation plans and developing policies to reduce seismic risk. This study addresses the assessment of the social vulnerability and resilience level of the city of Nablus, Palestine, a region affected by seismic events and political conflicts. The method employed is the Scorecard Approach, a self-assessment and participatory tool that measures resilience with qualitatively derived information at two different urban levels: population and local administration. The results enable the resilience assessment of different districts of Nablus concerning several themes relevant to disaster risk reduction. The latter facilitate the better understanding of how different variables – such as gender, age, educational level, monthly income and membership neighbourhood – influence the social vulnerability level. Furthermore, by applying a spatial analysis method to the case study region, it is observed that resilient indicators are not spatially random, but rather geographically correlated.

Keywords

Palestine, resilience, Scorecard Approach, spatial autocorrelation, vulnerability

1 Introduction

In the assessment of seismic risk a great deal of effort is usually dedicated to the analysis and evaluation of both the hazard and the physical vulnerability components, given the deep knowledge and research in the engineering seismology and earthquake engineering

fields (Borzi et al. 2013, 2015; Kagermanov et al. 2017a, 2017b). Nevertheless, for a more comprehensive evaluation of seismic urban risk, the importance of the role played by the communities during extreme events is becoming increasingly clear. In many developing countries characterized by high concentration of people in restricted areas and poorly regulated urbanization, a natural hazard can result in severe effects (Pazzi et al. 2016a). Populations have different capacities to prepare for an event, react in different manners, and recover from damages disproportionately, when they occur (Civiletti et al. 2016). The evaluation of social fragilities and lack of resilience of prone communities (Pazzi et al. 2016b), combined with the physical dimensions of a disastrous event, enables an overall assessment of urban risk, and fosters disaster resilient populations. Resilience, as defined by the United Nations International Strategy for Disaster Reduction (UNISDR), is “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (UNISDR 2009).

The first step towards disaster risk mitigation includes the evaluation of the community resilience, including a wise assessment of the surrounding habitat (Oliver et al. 2013; Costa and Kropp, 2013). Knowledge of gaps and vulnerable factors is a key prerequisite when trying to enhance the capacities of communities to respond to and recover from an event. Different techniques can be employed to give a measure of resilience: selection of variables highly connotative for the society (Jones and Andrey 2007), computation of indicators and indices (Freudenberg 2003), or participatory processes. A well-known example of the latter is the Scorecard Approach, a self-evaluation tool empowering city stakeholders to quantitatively assess risk and resilience parameters based on qualitatively derived information at multiple levels (Anhorn et al. 2014). This methodology was applied for the first time as a pilot study in Lalitpur, Nepal (GEM et al. 2014; Burton et al. 2014), and later on in Quito (Ecuador) as case study for South America (GEM 2013).

This paper describes the employment of the Scorecard Approach (Anhorn et al. 2014) in the Palestinian context within the activities of the EC-funded research project SASPARM 2.0 (Support Action for Strengthening PAlestine capabilities for seismic Risk Mitigation).

One of the major outcomes of the SASPARM 2.0 initiative is the development of an integrated seismic risk model for Palestine, based on a state-of-the-art hazard model and in-situ collected vulnerability and exposure data (Monteiro et al. 2016; Grigoratos et al. 2016). Moreover, great efforts are devoted to training of scientists, practitioners, students, citizens and stakeholders in order to raise awareness and capacity in the seismic field.

2 Sources of social vulnerability in Palestine

The city of Nablus (Figure 1.a), the first Palestinian city to join the UNISDR’s *Making city resilient campaign* (UNISDR 2010-2015), constitutes the case study area for the implementation and calibration of the model and the case study of this research. Palestine is exposed to several natural hazards including earthquakes. The entire region in and around Nablus (Figure 1.b) faced small to mid-scale disaster risk, and a large-scale urban disaster (Al Dabbeek 2010). Specifically, the seismic hazard is associated with the tectonic plate boundary in the Jordan Valley known as the Dead Sea Transform (DST). Historical records show that major earthquakes have caused severe damage and many hundreds, sometimes thousands, of casualties. The most recent significant earthquake (M_L 5.2) took place on February 11, 2004 (USAID MERC Project Team 2004) and the possibility of a major destructive earthquake is part of all contingency plan scenarios (UNDAC 2014).

3 Social vulnerability assessment

Social vulnerability assessment can be performed with different methods. The most commonly employed tool makes use of composite indicators, such as Human Development Index, Environmental Sustainability Index, Prevalent Vulnerability Index (sum of Exposure and Susceptibility, Socio-Economic Fragility and Lack of Resilience) and Social Vulnerability Index (Cutter et al. 2003). The indicator is a quantitative or qualitative measure, derived from observed facts, that simplifies and communicates the reality of a complex situation (Nardo et al. 2008). Social vulnerability indicators are potentially powerful tools because they summarize complexity and provide quantitative metrics to compare places and track progress (Tate 2012). Moreover, these indicators are relatively easy to be analysed by non-experts. Although indicators are increasingly recognized as useful tools for policy-making and public communication, since they can be used as performance measures, they can be misleading if poorly constructed or misinterpreted. Furthermore, indicators can lead to overly simplistic and inappropriate conclusions if dimensions of resilience are overlooked as a result from limited availability of data. The good quality of an indicator lies in the accessibility to information that is representative of the local knowledge, conditions, and context. Often, this kind of data is not accessible or not available from public databases (*i.e.*, national censuses). As such, for the Palestinian particular context, the design of targeted surveys was preferred with respect to an indicator-based methodology.

3.1 Scorecard Approach

Palestinian areas are highly affected by several restrictions and accurate census data is challenging to be found. A structured questionnaire, the so-called Scorecard Approach (Anhorn et al. 2014), is a good alternative method, given its participatory nature. It is also believed that this approach describes better the context because it has been customized for Nablus. Indeed, the citizens are the main actors of the assessment because the population directly replies to the proposed questions. In contrast to the time and resourceful – consuming interview approach (Siegrist and Gutscher 2008), a questionnaire is much simpler to fill in and can reach hundreds of locals, thus providing a sufficient statistical sample.

The purpose of the Scorecard Approach is to build a tool that can capture the key functional and organizational areas for urban resilience. The concept of resilience has found its way into disaster risk management as mentioned in the Hyogo Framework for Action (UNISDR 2005), which establishes the goal of “building resilience in nations and communities”. More recently, the United Nations started the campaign for urban disaster reduction with the banner “Making Cities Resilient”, defining the so-called 10 Essentials, which represent a set of indicators in the form of a checklist by which resiliency can be measured (UNISDR 2010-2015). The Scorecard Approach encompasses those ten essentials in six key dimensions that mainstream Disaster Risk Reduction (DRR) into planning and decision-making processes (Figure 2). The dimensions and the related main questions are summarized in Table 1.

The ideal outcome of the approach is the self-assessment of the population, who will then be able to better understand their own vulnerability and identify opportunities for resilience enhancement. Moreover, the results will enable local policy makers and communities to establish priorities for more in-depth analysis, allocate funds and develop emergency and disaster management programs more effectively.



Figure 2. UNISDR 10 Essentials representation integrated with the six dimensions of the Scorecard Approach to measure urban resilience (Anhorn et al. 2014)

3.2 Implementation in Nablus

The implementation of the Scorecard Approach in Nablus required a preparatory process to capture the local context into the design of the indicators (questions) and targets (answer schemes). The questionnaire preparation benefited from Palestinian academic experts' feedback, in particular from the Opinion Pools and Survey Studies Center of the local partner An-Najah National University. In this way, the development and implementation of the original Scorecard Approach have been carried out as a collaborative effort between the European and Palestinian Institutions involved in the SASPARM 2.0 project, in order to fine tune the questionnaire to the specificities of the local context and spread it among general population and the local administration individuals.

Table 1. Six Dimensions/Themes of the Scorecard Approach (Anhorn et al. 2014)

Dimensions/Themes	General Questions
Awareness and Advocacy (AA)	What is the level of awareness and knowledge of earthquake disaster risk?
Social Capacity (SC)	What are the capacities of the population to efficiently prepare, respond and recover from a damaging earthquake?
Legal and Institutional Arrangements (LIA)	How effective are mechanisms to advocate earthquake risk reduction in your quarter?

Planning, Regulation and Mainstreaming Risk Mitigation (PRMRM)	What is the perceived level of commitment and mainstreaming of DRR through regulatory planning tools?
Emergency Preparedness, Response and Recovery (EPRR)	What is the level of effectiveness and competency of disaster management including mechanisms for response and recovery?
Critical Services and Public Infrastructure Resilience (CSPiR)	What is the level of resilience of critical services to disasters?

The previous case studies of Lalitpur and Quito foresaw local workshops to have the opportunity of interaction between population, representatives of the administration and experts in the development of the approach (GEM et al. 2014; GEM 2013). Despite its advantages, such exchange was not possible in Nablus for safety reasons and even for language constraints. In order to overcome these challenges, the questions were translated and adapted to Arabic. Furthermore, university students were properly trained to support the filling in of the questionnaires, which were spread in different areas of Nablus involving the population in a very active way. The proposed questionnaire is presented as appendix.

4 Case study

For the purpose of the study, Nablus city was divided in seven neighbourhoods, based on the interaction with the local Municipality: Old City, Southern and Northern Mountain, Downtown, AlMakhfeya, Western and Eastern Areas (Figure 3). The city also includes Palestinian refugee camps (Balata, 'Askar and 'Ein Beit el Ma' – red markers in Figure 3), which include 6% of the participants, mostly located in the Northern Mountain, Western and Eastern Areas (The Applied Research Institute 2014).

The total number of collected questionnaires was 526, out of which 433 were filled by general population and the remaining 93 by local administration staff. When compared to previous initiatives (*e.g.*, the Lalitpur case study featured 43 participants in the workshop), the sample size in Nablus was much larger. The absence of a specific clarification seminar may have led to increased uncertainty in the results. However, it is expected that the large number of collected questionnaires helped reducing such effect. In detail, Figure 3 shows the percentage of questionnaires collected for each neighbourhood (a darker shade of green denotes a higher percentage of collected questionnaires). Northern Mountain has the largest percentage 22% (97 questionnaires), followed by the neighbourhoods Southern Mountain and Eastern Area, respectively with 19% and 18% (81 and 78 questionnaires). Western Area has a quote of 16% (71 questionnaires) and Old City 13% (58 questionnaires). Finally, in Downtown and AlMakhfeya 6% (24) of the questionnaires were collected.

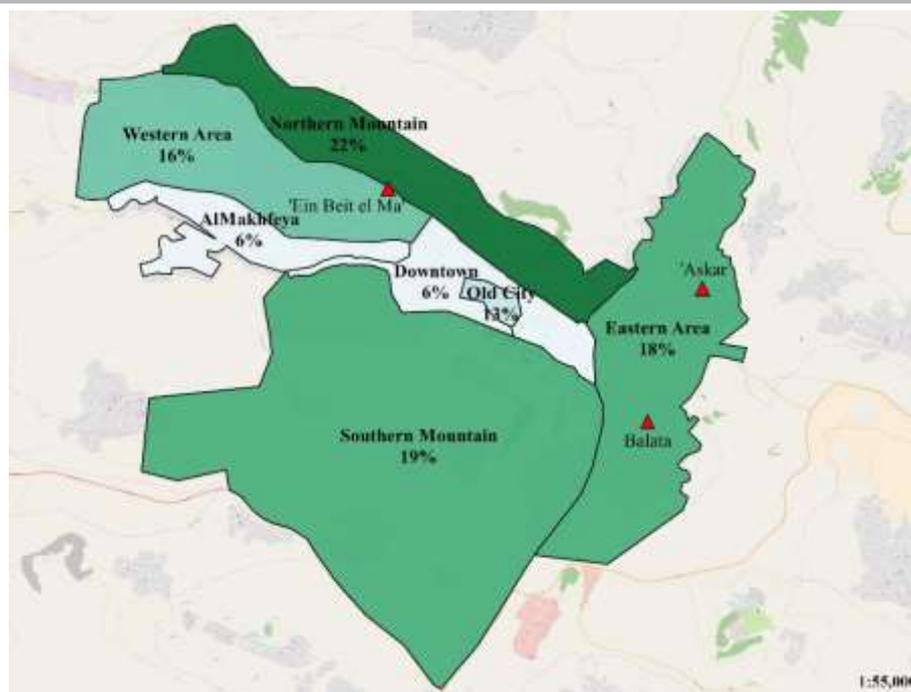


Figure 3. Questionnaire percentage distribution for the seven neighbourhoods in Nablus and identification of Palestinian refugee camps (red markers).

A scheme of answers was established to track progress on the mainstreaming of risk reduction. The possible answers were associated with five main scores, from 1 to 5 (Khazai et al. 2015), as detailed in the following.

(1) **High:** “Full integration”. This level refers to a situation where risk reduction is fully absorbed into planning and development processes as well as core services. This level describes a situation where DRR is “institutionalized”. However, this is not to suggest that an optimum level of attainment has occurred: there is still a need for further progress.

(2) **Moderate:** “Engagement and commitment”. The level refers to a high level of engagement and commitment to DRR. However, the policies and systems have not been fully established yet.

(3) **Low:** “Awareness of needs”. This level refers to an early stage of awareness. The institutions may have activities and dedicated efforts for preparedness, however, these initiatives are simply limited to response. This level is expected not to result in risk reduction in the long term and vulnerability is expected to increase.

(4) **Almost none:** “Little awareness”. There is no institutional policy or process for incorporating risk reduction within the functions and operations of the organization. The probable result is a great vulnerability and high losses in the future.

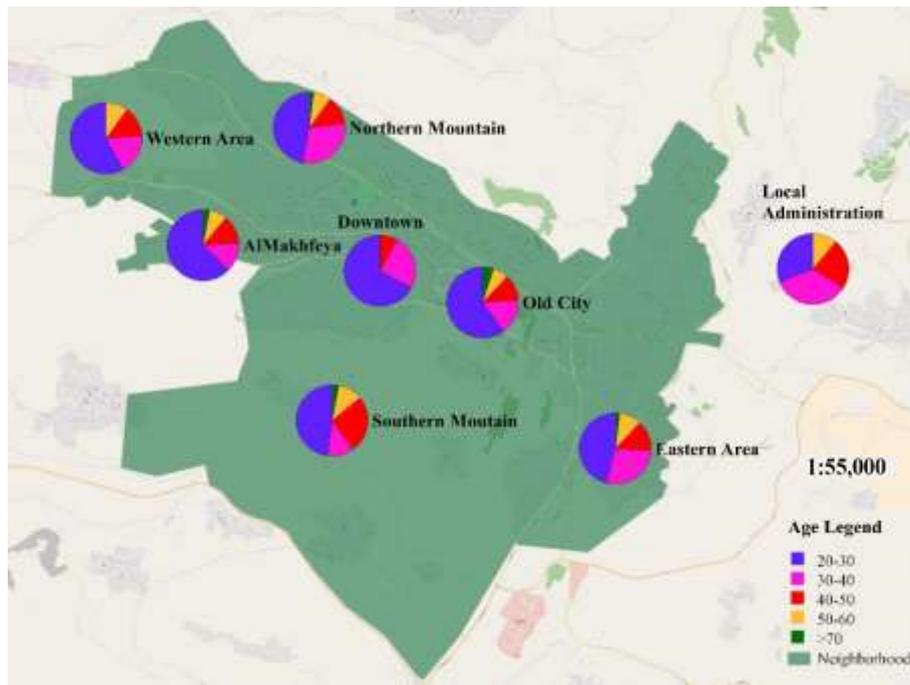
(5) **Not awareness.** Population is not aware or informed of any kind of processes and municipality does not act to address problems. In some cases, there is an adverse attitude and adverse institutional culture towards adopting measures to reduce risk. The not-awareness implies a high level of vulnerability and lack of resiliency.

Six of the total 39 questions had less possible answers, which led to just three corresponding scores: 1 (High), 4 (Almost none) and 5 (Not awareness). The different scheme for those 6 questions was adopted to render the questionnaire easier to understand by the Palestinian citizens.

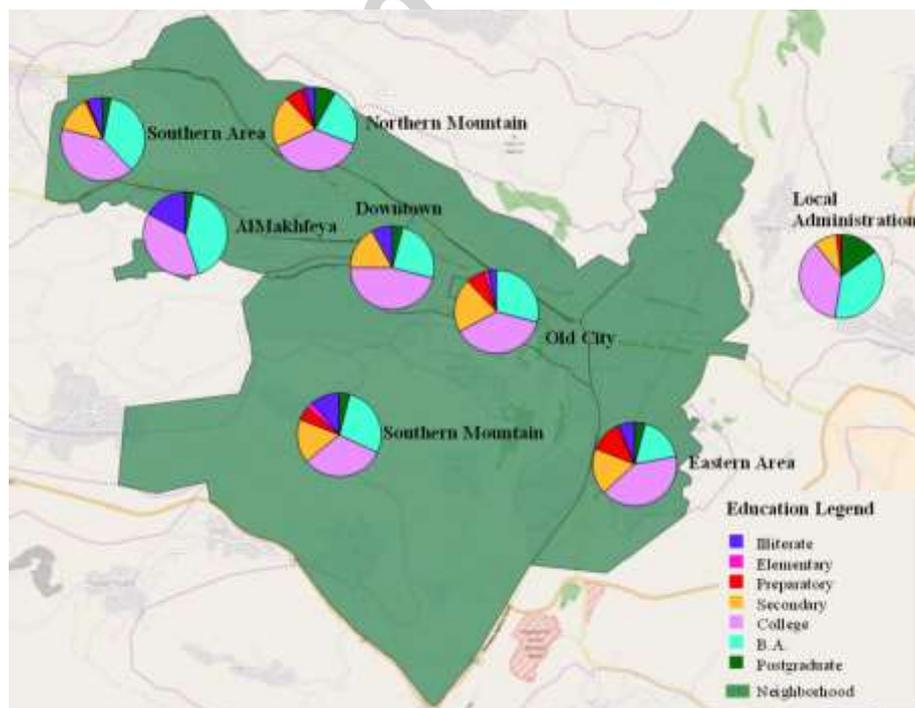
5 Global and detailed results

The gender distribution of the general population respondents is homogeneous: 51% male and 49% female, whereas the local administration features a higher percentage of men

(56%). Preliminary quantitative evaluations were performed regarding age, educational level and monthly income, as shown in Figure 4. The age of the respondents ranges mostly between 20 and 30 years old (53%) whilst a non-negligible percentage (27%) is between 30 and 40 years old (Figure 4.a). This information is closely correlated to the educational level (Figure 4.b), particularly when referring to university students (38%) and bachelor degrees (27%). Very aggregated answers were obtained for the monthly income (Figure 4.c): about 47% of respondents declared 1500 – 3500 NIS (1NIS = 0.26USD), 17% stated about 0 – 1500 NIS whilst 18% did not answer at all.



(a)



(b)

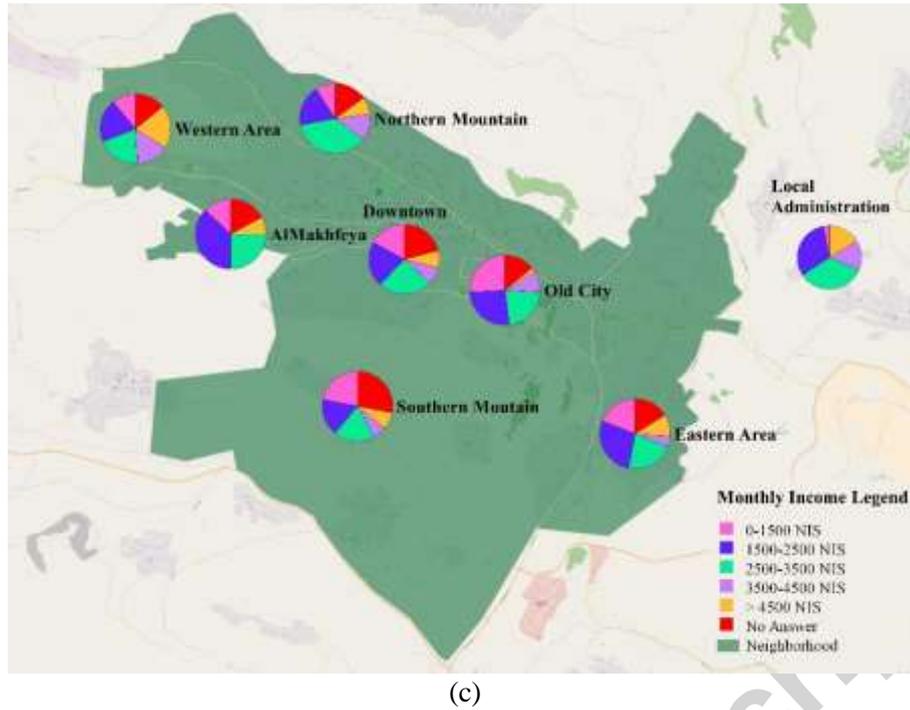


Figure 4. (a) Age, (b) Education level, and (c) Monthly income distributions for the collected questionnaires at the different neighbourhoods. **1:55,000**

From a global perspective, not taking into account the specific themes previously explained in Table 1, the results for population and local administration staff, divided by percentages of each score, are shown in Figure 5. The results are almost equally spread among the five scores; specifically, most of the answers belong to the range of “moderate” to “almost none awareness” for both groups.

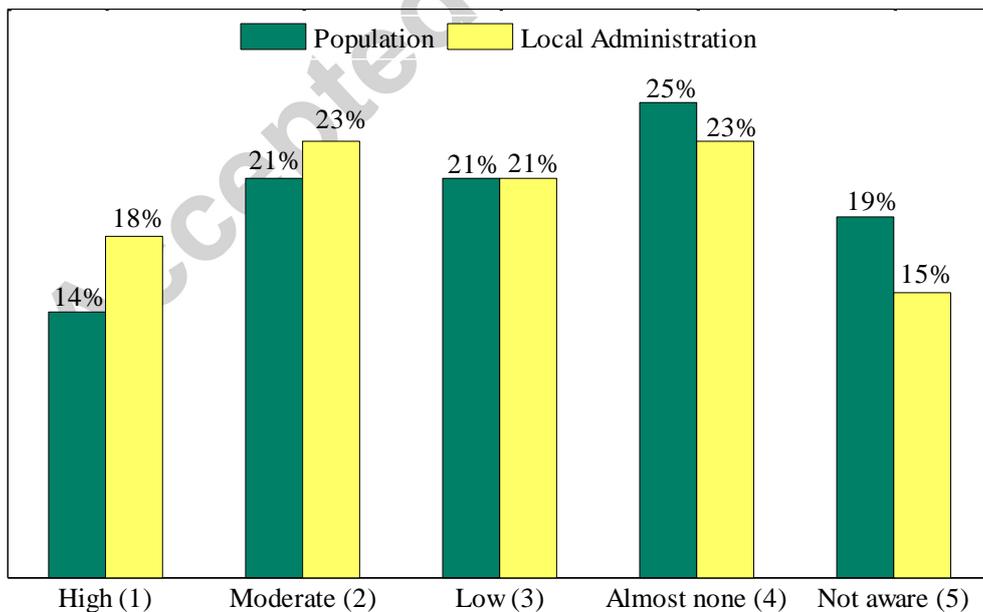


Figure 5. Distribution of the scores divided between population and local administration.

Looking at the mean scores per theme for each neighbourhood and for the administration representatives, as illustrated in Figure 6, the highest values are found for the themes of “Planning, Regulation and Mainstreaming Risk Mitigation”, “Critical Services and Public Infrastructure Resilience”, “Emergency Preparedness, Response and Recovery” and “Legal and Institutional Arrangements”. The population mean scores range between 2.7 and 3.6, with the latter score being found for the theme of “Planning, Regulation and Mainstreaming Risk Mitigation”. In detail, the Eastern Area and Old City are above the general population mean in four of the six themes. On the other hand, as expected, the local administration group exhibits a lower score respect to the mean population for all the themes. This result demonstrates a better perception, as well as risk management and reduction capacities of the administration with respect to the general citizens. However, for what concerns institutional arrangements, planning, and regulations, both groups provided very similar responses, which appears to indicate that, despite all, the local administration group is managing to pass relevant information on to the general population.

Figure 6 also includes the dispersion around the collected answers, measured in terms of coefficient of variation (COV). On average, the mean score of each theme is associated to a coefficient of variation ranging roughly between 35% and 65% (standard deviation of 1.30 for the general population and 1.28 for local administration). These numbers denote a relatively high dispersion, which indicates that the perception of the citizens across the different themes and questions varies highly hence a more detailed scrutiny is required. Local administration has a mean that varies between 2.5 and 3.5, meaning moderate to low awareness even in the decision-making bodies.

Figure 7 illustrates the average distribution of the scores for all the questions of each theme. As explained earlier, the possible answers were associated to five main scores, from 1 to 5 (1 – full awareness, 5 – no awareness or information at all about any kind of risk reduction related processes). The internal consistency of the proposed questions has been tested through the parameter Cronbach’s alpha, which provides an overall assessment of the test reliability. The coefficient is 0.87, denoting a high covariance among the different questions.

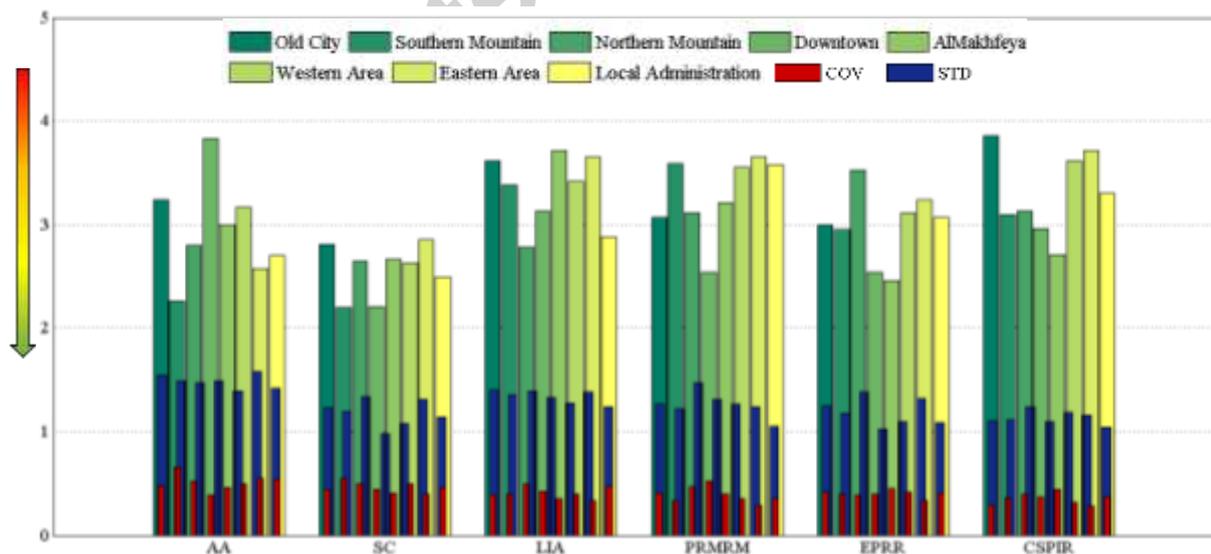


Figure 6. Representation of mean scores, coefficient of variation and standard deviation per theme for each neighbourhood and local administration

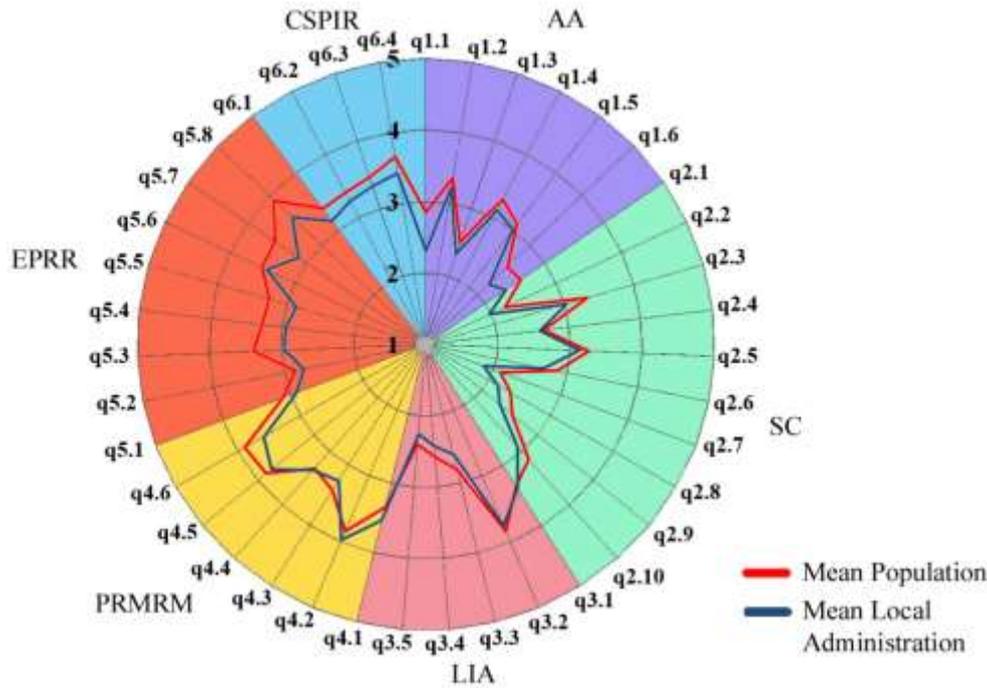


Figure 7. Distribution of mean answer score per each question according to population and local administration.

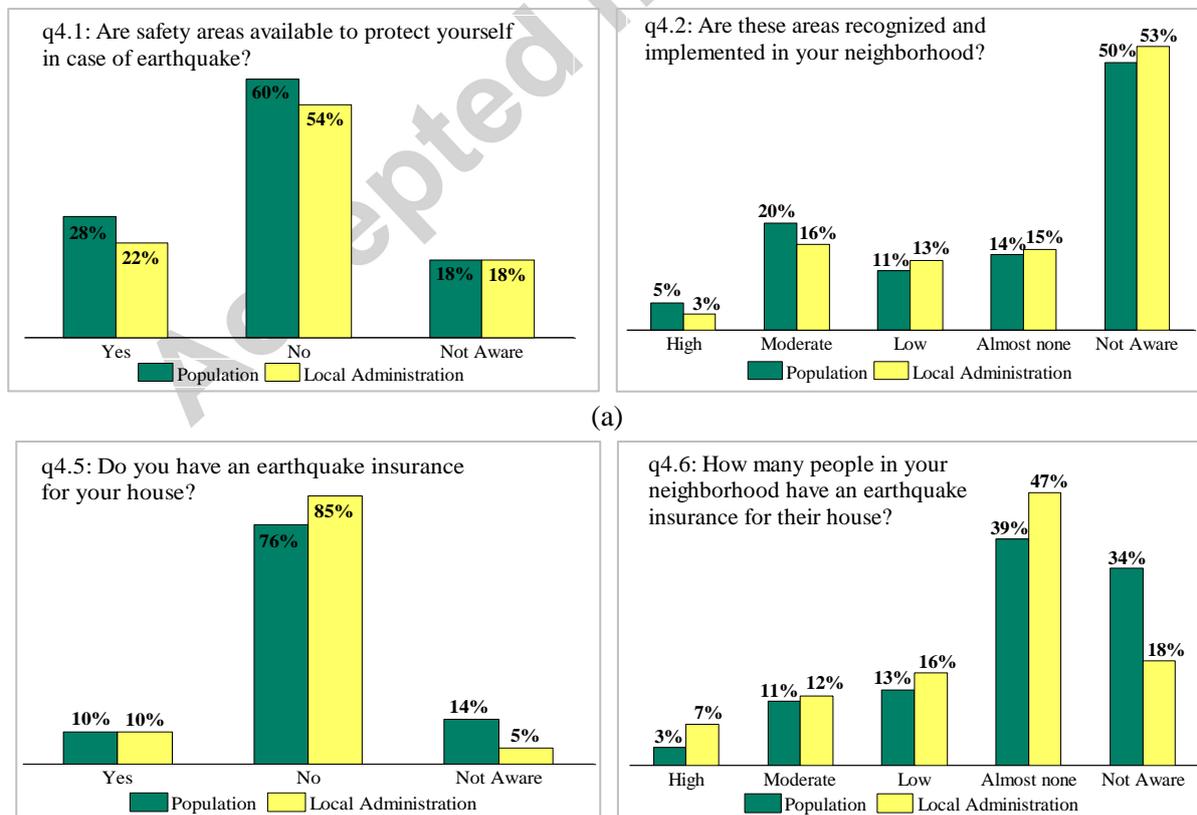
Generally, the trend of the average answers for general population and local administration is very similar along all the themes, although the scores for the latter are slightly lower. The difference between the mean is not so significant, which foresees, many times, a low level of resilience even in decision making bodies. The highest values, *i.e.*, lowest perception of risk, for the general population group come from the themes “Planning, regulation and mainstreaming risk mitigation”, “Critical services and public infrastructure resilience”, “Emergency preparedness, response and recovery” and “Legal and institutional arrangements”. High scores are also observed for the local administration respondents when the themes “Planning, regulation and mainstreaming risk mitigation” and “Legal and institutional arrangements” are considered.

Specifically, there are four peak scores within the “Planning, regulation and mainstreaming risk mitigation” theme, which denote particularly high vulnerability (q4.1, q4.2, q4.5, q4.6). Those four questions, for which results are detailed in Figure 8.a and b, are mainly related to the availability and implementation of safety areas and insurance for buildings. This couple of questions follows the standard procedure of first asking about the general problem, e.g., the availability of safety areas or earthquake insurance, and, secondly, going into further detail requiring higher level of knowledge, e.g., the implementation of the above-mentioned safety areas and the availability and use of insurance products. This procedure is generally followed in all the themes and examples are included in Figure 8.a, b and c. Question q4.1, referring to the availability of safety areas, reveals a higher mean score for local administration with respect to general population. A close-up on this question proves that a very high percentage of local administration staff does not clearly recognize any areas to protect themselves when an earthquake occurs (Figure 8.a-left) and only 22% really knows where to go in that case. The respondents who identified such safety areas did not know if the zones are actually implemented in their neighbourhood (Figure 8.a-right). Even more evident is the situation regarding insurance availability (q4.5): 76% of the general population and 85% of the local administration staff do not have any earthquake related insurance product for their buildings (Figure 8.b-left). It is possible that a misunderstanding took place regarding this

question, given that 10% of both general population and local administration indicate to have an earthquake related insurance. Indeed, this insurance coverage does not exist in Nablus and the respondents could be referring to another kind of insurance. Moreover, when asked about how many people in their neighbourhood have insurance coverage, 73% of the general population and 65% of local administration members answered “almost none” or “not aware” (Figure 8.b-right).

Additional peaks are also observed for “Legal and Institutional Arrangements” and are related to the existence of specific ordinances and regulations for earthquake safety and risk reduction (q3.1, q3.2, Figure 8.c). The detailed results of the questions related to the availability of such ordinances do not denote any explicit trend, as the percentages are equally spread between the three possible answers (Figure 8.c-left), with a very significant share of not-awareness. With respect to question q3.2, related to the effectiveness of the ordinances, it is confirmed that both general population and local administration groups are indeed not aware of this topic (47 and 46%, respectively) or think that regulations have a low effectiveness (20 and 21%, respectively, Figure 8.c-right). “Emergency preparedness, response and recovery” questions were generally related to the availability of human force, funds and material resources, such as the ones related to sheltering needs (Vecere et al. 2016, 2017). Population and local administration agree that the provision of shelters and food is essentially lacking for a post-earthquake emergency (Figure 8.d). Moreover, a significant percentage of general population respondents (32%) are not aware of the availability of this kind of resources.

Whereas the above-mentioned questions concern the peak cases, high vulnerability levels were also denoted for other sets of questions. “Critical Services and Public Infrastructure Resilience” topic has only scores above 3, with a peak in q6.4 (Figure 7). The theme mainly relates to retrofitting measures for critical infrastructures (*i.e.*, hospitals and schools), non-structural improvements and plans for repair of critical lifelines (q6.4). Most likely, these subjects are too technical and require deep knowledge in risk management that often lacks, also at the administration level.



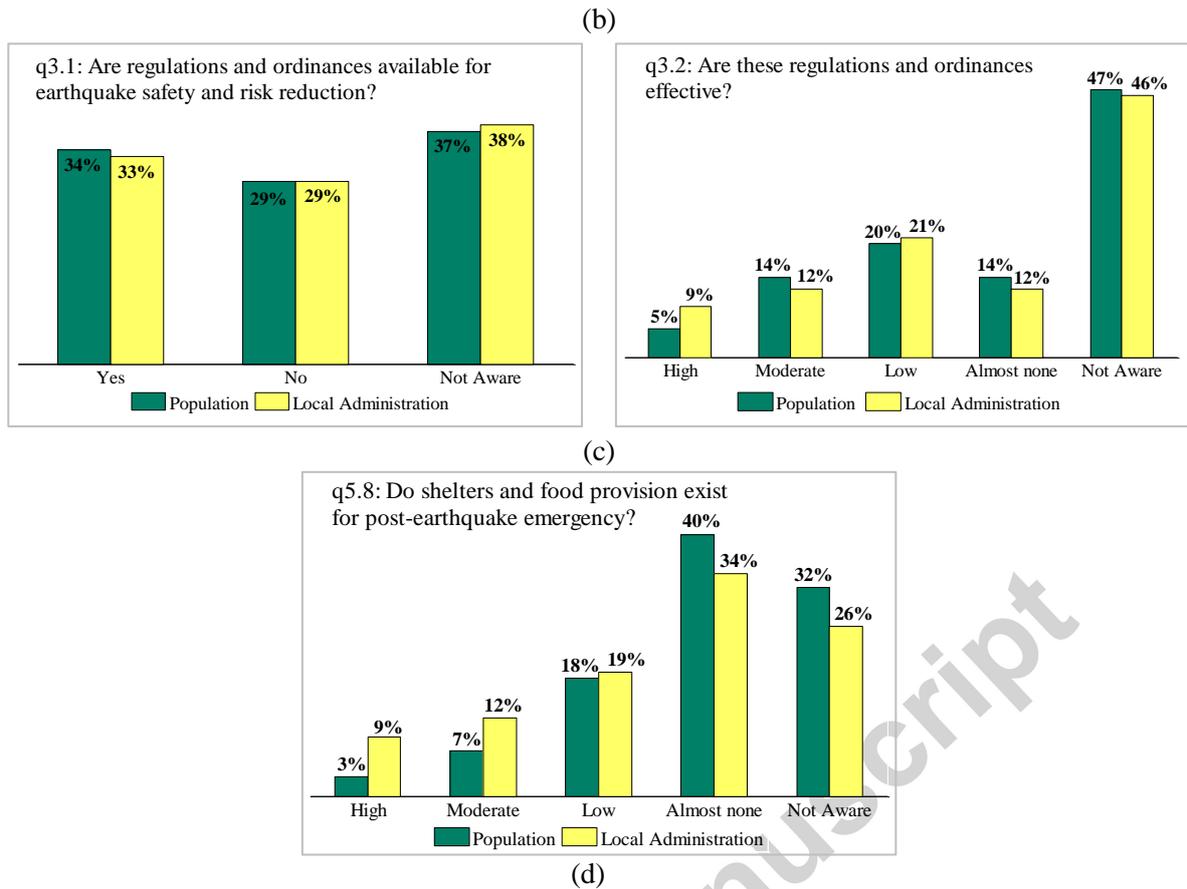


Figure 8. (a) Availability and implementation of safety areas; (b) Availability of housing insurance; (c) Availability and effectiveness of regulations; (d) Emergency preparedness, response and recovery. All the selected questions have the peak score in Figure 7.

A principal content analysis (PCA) was performed to check the validity of how the selected items cluster at the level of hypothetical constructs. PCA can be regarded as an equally robust methodology, with respect to a confirmatory factor analysis, which represents structural equation modelling. Both methods allow for inclusion of binominal variables in one statistical model and therefore to test how the constructs, in this case clusters of factors, are consistent with the understanding of the factors of these constructs, as well as the variability among correlated variables. It was also assumed that the sampling of 39 items and 500 cases is sufficient for robust conclusions based on the application of the PCA method. The PCA results are presented in Table 2, which demonstrates how all eigenvalues are greater than 1 therefore that they can load on the constructs.

Table 2: Eigenvalues for six clusters

Cluster	Eigenvalues
AA Awareness and Advocacy	2.772
SC Social Capacity	2.300
PRMRM Planning, Regulation and Mainstreaming Risk Mitigation	2.136
LIA Legal and Institutional Arrangements	1.992
EPRR Emergency Preparedness, Response and Recovery	1.637
CSPiR Critical Services and Public Infrastructure Resilience	1.460

5.1 Normalized resilience index

Using the vulnerability scores obtained with the collected questionnaires a resilience index will now be used, in a normalized fashion. With some level of simplification, resilience can be defined, in general terms, as inversely proportional to the vulnerability. As such, a direct relationship between maximum vulnerability (score 5) and minimum resilience has been assumed. In order to make the comparison of results more homogenous, a linear max-min normalization has been computed per theme and per neighbourhood, according to Eq. 1, with the computation of the Normalized Index, $NI_{i,j}$ (GEM 2013). This index is given by the score of the neighbourhood i for theme j , normalized with respect to max and min (respectively, the maximum (5) and minimum (1) possible scores for the theme) and avg (the average of all scores for the neighbourhood).

$$NI_{i,j} = \frac{avg_i - min_j}{max_j - min_j} \quad (1)$$

By using this normalized scale (illustrated in Figure 9) general considerations among themes can be performed and a better comparison of results coming from the different neighbourhoods and the local administration group can be carried out. Values close to 0 represent very high resilience whereas values close to 1 indicate very low resilience (almost none). Generally, $NI_{i,j}$ values are proportional to the social vulnerability level and inversely proportional to the resilience level.

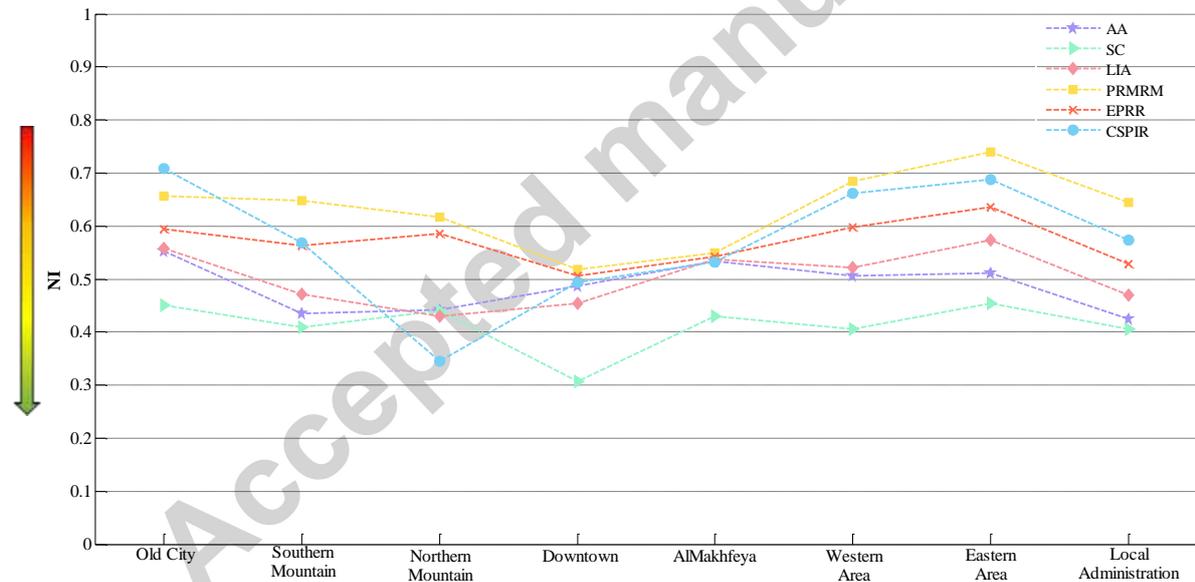


Figure 9. Normalized resilience index (NI), divided by theme, per each neighbourhood and local administration

The results in Figure 9 denote a general low resilience level for the themes “Planning, regulation and mainstreaming risk mitigation”, “Critical services and public infrastructure resilience” and “Emergency preparedness, response and recovery” across all the neighbourhoods (with the exception of “Critical services and public infrastructure resilience” in Northern Mountain). Even the local administration group exhibits peaks of 0.64, 0.57 and 0.53, respectively, for those topics. In terms of the neighbourhood, there is a general tendency for Western and Eastern Areas (more peripheral) to present lower resilience whereas Downtown and AlMakhfeya present higher homogeneity among all themes and relatively

low index hence higher resilience. Old City and Southern and Northern Mountains are much more variable in terms of results, ranging from 0.35 to 0.71 normalized index. Moreover, Southern Mountain, Western and Eastern Areas display the same order of resilience indices across all the themes.

When evaluating the percentage of results by ranges of resilience (Table 3), for most of the themes and for both local administration and general population, the global outcome indicates a “low” to “almost none” level of resilience. Indeed, most of indices vary between “low” (75%) and “almost none” (21%).

Table 3. Percentage of answers by ranges of resilience.

Ranges of resilience	Percentage of answers	
High	0.0 – 0.1	0%
	0.1 – 0.2	0%
Moderate	0.2 – 0.3	0%
	0.3 – 0.4	4%
Low	0.4 – 0.5	33%
	0.5 – 0.6	42%
Almost none	0.6 – 0.7	17%
	0.7 – 0.8	4%
Not Aware	0.8 – 0.9	0%
	0.9 – 1.0	0%

With all the aforementioned results in mind, it is necessary to prioritize “Planning, regulation and mainstreaming risk mitigation”, “Critical services and public infrastructure resilience” and “Emergency preparedness, response and recovery” topics in order to improve the resilience of the city. These themes encompass several aspects regarding risk and its management, such as availability and usability of safety areas, enforcement of building codes, retrofitting measures. As already highlighted in the previous evaluations of the peak scores, measures to prevent and recover from an earthquake should be enhanced. Implementation should be foreseen not only in private buildings but also in critical infrastructures along with non-structural improvements such as extra generators for electricity, spare pumps for water supply systems, etc. Post emergency plans are also lacking and, for this reason, training on earthquake safety is necessary and crucial to improve the social resilience.

5.2 Statistical dependence of variables

Further statistical post-processing of the data has been performed to assess which variables have a higher effect on the general population answers. MANOVA (multivariate analysis of variance) was employed, as it allows to analyse groups of data involving more than one dependent variable at a time. MANOVA tests hypotheses regarding the effect of one or more independent variables on two or more dependent variables. In this study, the dependent variables were the questions of each theme, whereas the independent variables were the neighbourhood, gender, age, educational level, and monthly income. The results are shown in Tables 3 to 5, where the larger the circle is the more the considered variable affects the corresponding theme. The dependency to the several variables has been tested considering a p-value (reported in all the following tables) significance level of 0.05.

Table 4. MANOVA results with single variable (dependence level and p-value)

Neighbourhood	Gender	Age	Education	Income
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AA		$8.1 \cdot 10^{-5}$		$4.6 \cdot 10^{-2}$		$1.1 \cdot 10^{-2}$		$6.8 \cdot 10^{-4}$		$2.9 \cdot 10^{-3}$
SC		$4.4 \cdot 10^{-5}$		0.22		0.90		$2.5 \cdot 10^{-4}$		$4.7 \cdot 10^{-2}$
LIA		$1.8 \cdot 10^{-4}$		$1.3 \cdot 10^{-3}$		0.86		0.83		0.06
PRMRM		$4.9 \cdot 10^{-8}$		0.12		0.08		$2.5 \cdot 10^{-4}$		0.29
EPRR		$8.3 \cdot 10^{-7}$		0.40		0.40		$1.7 \cdot 10^{-2}$		0.26
CSPIR		$2.03 \cdot 10^{-6}$		0.32		0.81		0.09		0.31

It is very clear from Table 4 that the neighbourhood plays a major role in all the themes. Education level comes next, as a relevant variable to awareness, social capacity, planning and regulation, which is easy to understand and to expect. This outcome is confirmed by the results in Table 5, showing the statistical dependence level when coupling different variables rather than considering each variable individually. Indeed, neighbourhood and education level, when considered together, are the ones that exhibit a stronger correlation with some of the themes (the same that were particularly affected by the education level variable).

Table 5. MANOVA results with two variables (dependence level and p-value)

	Neighb.+Edu.		Income+Gender		Income+Edu.		Income+Neighb.		Neighb.+Gender	
AA		$5.9 \cdot 10^{-5}$		$2.7 \cdot 10^{-3}$		$2.7 \cdot 10^{-3}$		$2.9 \cdot 10^{-3}$		$8.1 \cdot 10^{-5}$
		$1.1 \cdot 10^{-4}$		$1.5 \cdot 10^{-2}$		$3.4 \cdot 10^{-3}$		0.35		0.8
SC		$3.9 \cdot 10^{-5}$		$4.8 \cdot 10^{-3}$		$4.5 \cdot 10^{-3}$		$4.2 \cdot 10^{-3}$		$4.4 \cdot 10^{-5}$
		$3.6 \cdot 10^{-3}$		0.25		0.012		0.016		0.13
LIA		$1.9 \cdot 10^{-4}$		0.06		0.06		0.64		0.17
		0.86		0.03		0.75		$1.8 \cdot 10^{-2}$		0.09
PRMRM		$4.9 \cdot 10^{-8}$		0.29		0.28		0.28		$4.7 \cdot 10^{-8}$
		$4.5 \cdot 10^{-3}$		0.11		0.06		0.06		$1.4 \cdot 10^{-2}$
EPRR		$7.6 \cdot 10^{-7}$		0.27		0.26		0.26		$8.86 \cdot 10^{-7}$
		$1.7 \cdot 10^{-2}$		0.44		0.02		0.11		0.35
CSPIR		$1.9 \cdot 10^{-6}$		0.31		0.31		0.31		$2.1 \cdot 10^{-6}$
		0.07*		0.37		0.08		0.47		0.34

* When one variable has a very low p-value and the other is slightly over the significance level of 0.05, the combination of the two variables is considered relevant.

Smaller relevance can be observed for the “neighbourhood membership–gender” combination in “Planning, regulation and mainstreaming risk mitigation” theme and for the “neighbourhood membership–income” pair in “Social Capacity” matters. On the other hand,

educational level, which plays an active role in increasing awareness towards disaster risk, demonstrates a significant influence on the respondents in three topics only (Table 4). The pair “education–monthly income” has influence in two cases: “Awareness and advocacy” and “Social capacity” (Table 5). This confirms how educational empowering in association with socioeconomic status increases the level of awareness, knowledge about risk, and recovery potential (Burton and Silva 2015). At the same time, it is interesting to note that “Legal and Institutional Arrangements” does not present any particular dependence on any of the tested variables. Similar considerations can be made for the themes “Critical services” and “Emergency preparedness, response and recovery” that show a dependence only with the pair “neighbourhood membership–educational level”. This means that these are cross-cutting themes affecting all population layers in the same manner.

If the combination of three or more variables is considered, a non-negligible interdependence can be observed between educational level, income, age and gender (Table 6), even if specific to the “Awareness and advocacy” theme. This result instead denotes how the ability of people to understand information, access to recovery and resources depends on a combination of several variables.

Table 6. MANOVA results with three and four variables (dependence level and p-value)

		Edu. + Income + Age	Edu. + Income + Gender	Edu. + Income + Neighb.	Edu. + Income + Gender + Age
AA		3.1·10 ⁻³	3.3·10 ⁻³	3.4·10 ⁻³	3.3·10 ⁻³
	●	2.1·10 ⁻³	●	2.8·10 ⁻³	●
		2.1·10 ⁻³	1.1·10 ⁻²	0.35	0.01
SC		0.43	1.1·10 ⁻²	0.012	0.011
		2.5·10 ⁻²	0.46	●	4.6·10 ⁻³
		0.86	0.17	0.016	0.17
					0.80

Furthermore, it was also checked whether the dependent variables are normally distributed with the non-parametric test, which is based on ordering of distributions and also represents step-wise regression and determines if the variables are important. The outcome of the non-parametric test is presented in Table 7. The results for dependent variables show the asymptotic significance about the significance level of 0.05.

Table 7: Results of non-parametric test

		N	Correlation	Sig.
AA	Neighbourhood, gender, age, education, income	500	0.057	0.369
SC	Neighbourhood, gender, age, education, income	500	0.039	0.343
LIA	Neighbourhood, gender, age, education, income	500	0.019	0.267
PRMRM	Neighbourhood, gender, age, education, income	500	0.040	0.359

EPRR	Neighbourhood, gender, age, education, income	500	0.035	0.322
CSPIR	Neighbourhood, gender, age, education, income	500	0.029	0.310

6 Spatial analysis

The results presented previously underlined the dependence of the variables with the neighbourhoods considered as geographical units. For that reason, a further analysis has been performed to assess the spatial distribution of the social vulnerability level in the city. Statistically, a spatial analysis can: (i) highlight clustering regions, which encompass a strong relationship between the areas, or (ii) atypical location of spatial outliers. The identification of such spatial relation, particularly referring to high-risk neighbourhoods, can help in the intervention and targeting of emergency resources for the city of Nablus.

The global spatial autocorrelation can be quantified by the Moran's I , a statistical parameter that measures the degree to which a variable is correlated across neighbouring spatial units (Anselin 1996). Graphically, the Moran scatter plot is a useful tool for exploratory analysis of this sort because it enables to assess how similar an observed value is to its neighbouring observations. The scatter plot is centred on the mean and the values in both axes are standardized so that the units in the graph correspond to standard deviations. The variable of interest ($NI_{i,j}$) is represented on the x-axis and the weighted average of the neighbouring variables on the y-axis (Anselin et al. 2000). In the complete absence of spatial dependence, the Moran's I statistic has a value of zero while higher or lower values indicate geographical clustering.

Figure 10.a shows, as an example, the Moran scatter plot computed for the resilience index of "Social capacity" theme. The Moran's I coefficient is -0.527 and is graphically represented by the slope of the blue line running through the scatterplot (Anselin et al. 2000). This negative sign of this coefficient shows that, in general, the neighbourhoods are surrounded by dissimilar values. The points on the scatterplot, depending on their position, express the level of spatial association of each district with its neighbouring. The neighbouring relationship is based on common boundaries, *i.e.*, the contiguity of borders and vertices with the surrounding districts. The two points in the lower left (or low-low) quadrant – Southern Mountain and Western Area – indicate positive spatial association of values (spatial clusters). The lower right (or high-low) and upper left (or low-high) quadrants represent the remaining five observations – Northern Mountain, Eastern Area, Old City, AlMakhfeya and Downtown, respectively – that exhibit negative spatial association (spatial outliers), meaning that these observed values carry little similarity to their neighbouring ones. All the Global Moran's I statistics have been successfully verified to the p-value significance level of 0.05.

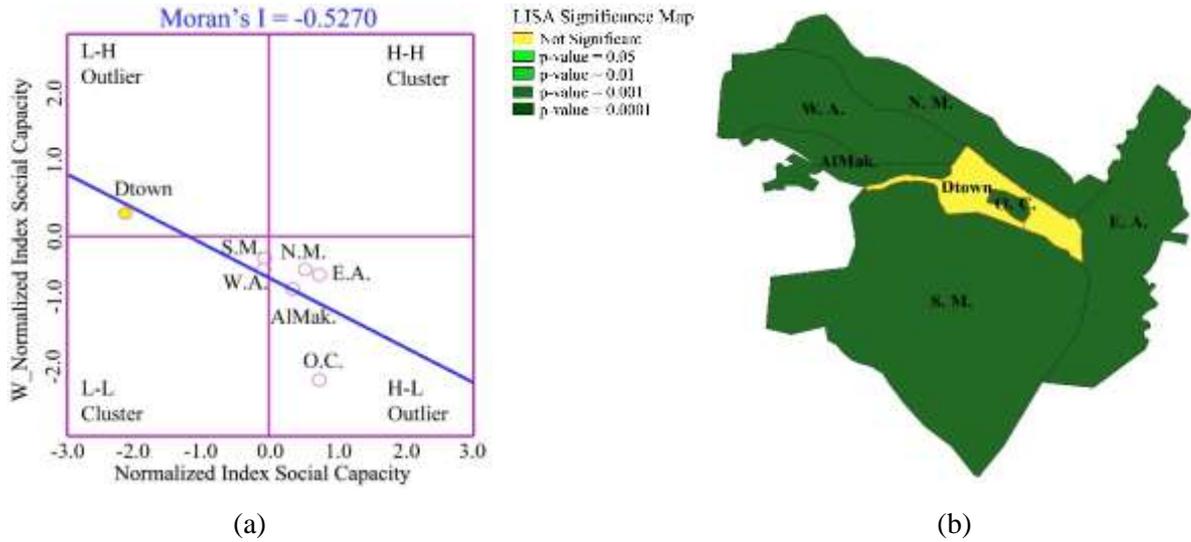
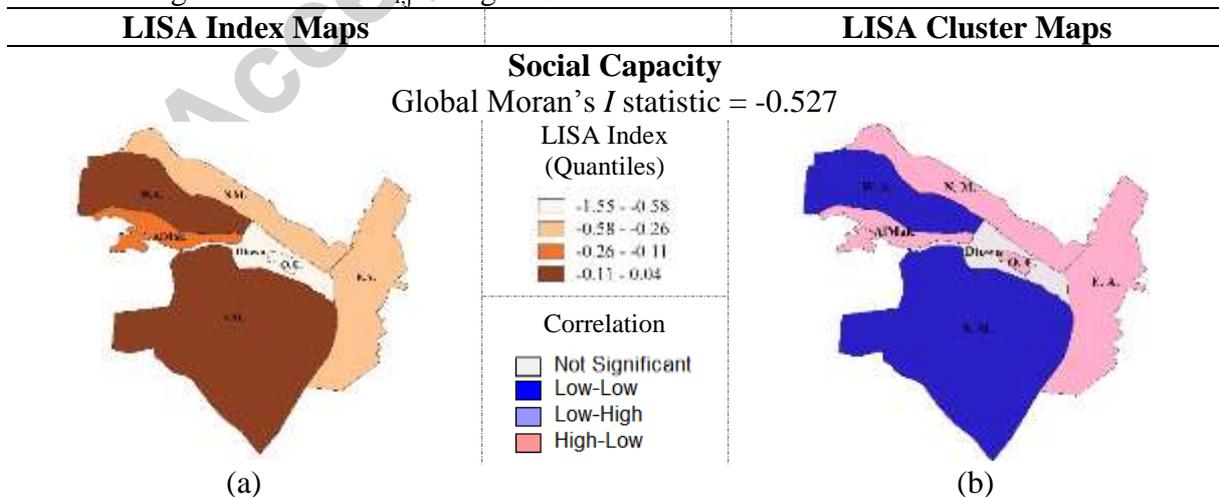


Figure 10. (a) Global Moran scatter plot, and (b) LISA Significance map for resilience index of the “Social capacity” theme

The global Moran scatterplot suggests indeed non-randomness in the overall spatial pattern, however this statistical parameter only indicates the presence of globally spatial autocorrelation, not providing information on the specific locations of spatial patterns (Holt 2007). A focus on where such non-randomness may be located, in terms of significant clusters or spatial outliers, is provided by an analysis of the local indicators of spatial association (LISA) (Anselin 1995). This method computes a measure of spatial association for each individual observation, through significance and cluster maps.

The significance map employs the local Moran’s I which is able to identify the local level of spatial autocorrelation, and does not consider the global value of Moran’s I . The map shows the locations with a significant local Moran’s I in different shades of green, depending on p-values, which will yield really significant locations when lower than 0.05 (Figure 10.b). According to Figure 10.a, one point in the upper left quadrant (corresponding to the yellow area) does not have a significant p-value, hence, is not spatially related to the surrounding neighbourhoods.

Figure 11 presents the LISA Index and Cluster maps for the index of resilience concerning the three themes of the Scorecard Approach found to be more relevant for their lower and higher values of $Nl_{i,j}$ in Figure 9.



Planning, regulation and mainstreaming risk mitigation
 Global Moran’s I statistic = -0.364

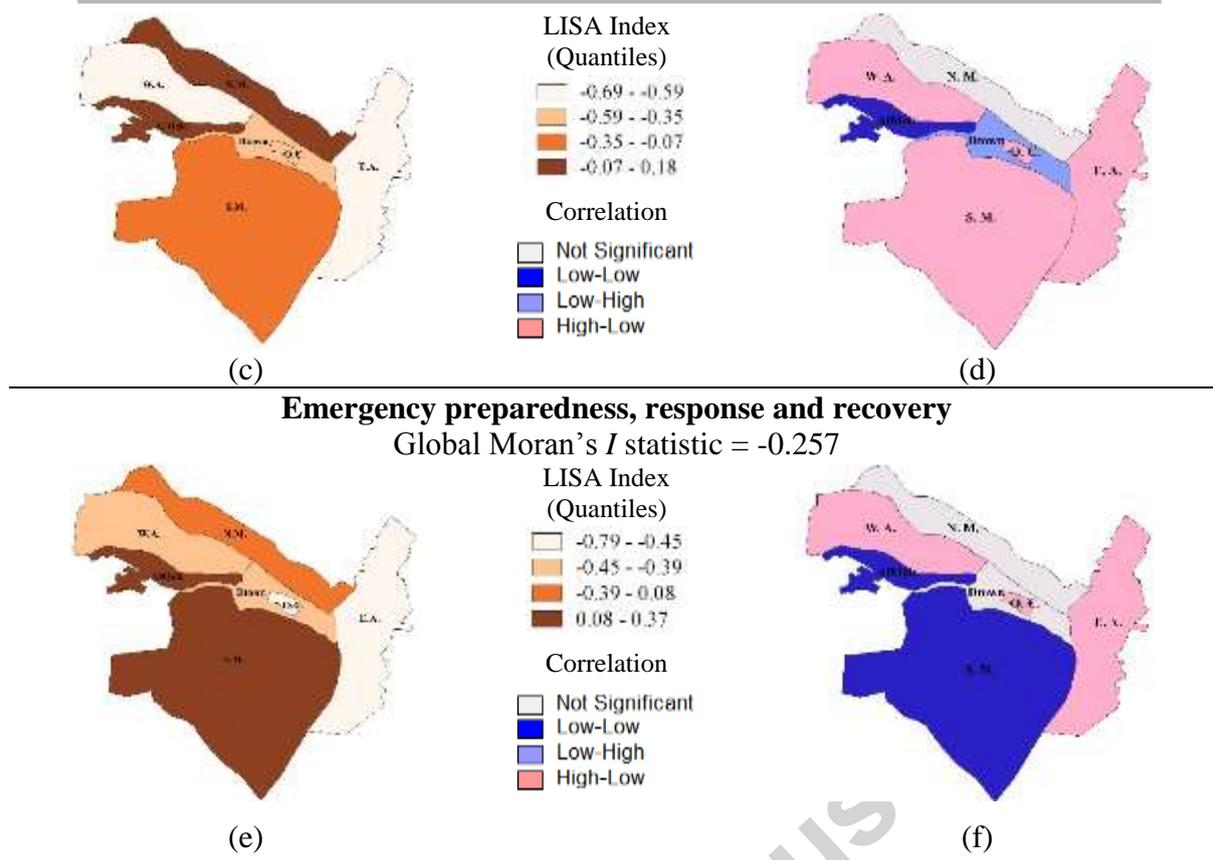


Figure 11. LISA Index and LISA cluster maps for resilience index for three selected themes

The LISA indices, divided in categories of quantiles (which include, as much as possible, an equal number of neighbourhoods in each category), are represented in the maps of Figure 11.a, c and e, highlighting how the local spatial correlation varies for each neighbourhood over the case study region. The LISA indices are statistically different from 0, indicating that the analysed area is spatially associated to its neighbours (Dalposso et al. 2013). The sum of all local indices is proportional to the Global value of Moran's I statistic. On the right, the maps display three categories of spatial autocorrelation: one indicating clusters and two indicating outliers. The blue colour shows areas where low $NI_{i,j}$ values are surrounded by low values (low-low), whereas high values surrounded by low resilience index values and low resilience index values surrounded by high values are considered as spatial outliers (light blue and pink colours, respectively). Furthermore, the non-significant regions have also been identified, whenever the corresponding p-values were greater than 0.05.

Considering the theme "Emergency preparedness, response and recovery" in Figure 11. e, three neighbourhoods – AlMakhfeya, Southern Mountain and Northern Mountain – show positive LISA indices. Focusing on this topic, Northern Mountain is in the high-high quadrant of the Moran scatterplot, whereas the other two neighbourhoods are in the low-low quadrant. Although the Northern Mountain could be considered a cluster, it fails the statistic test reaching a p-value of 0.34 and, for this reason, the neighbourhood is considered not significant.

Analysing the Cluster maps instead (Figure 11.b, d and f), the Eastern Area neighbourhood has a high-low pair of values for all topics, which means that, in general, the neighbourhood presents high values of resilience index and is surrounded by lower ones. The high values of resilience index confirm that the Eastern Area is a more socially vulnerable region in comparison to the other parts of the city. On the opposite side, the only case of low-

high value has been found in Downtown neighbourhood for “Planning, regulation and mainstreaming risk mitigation”. Other high-low combinations (not reported herein) have been also detected for the Western Area with the exception of two themes, “Awareness and Advocacy” and “Social Capacity”. The former neighbourhood has been identified as not significant, whereas the latter is a low-low cluster (Figure 11.b).

Southern Mountain is a cluster region in two cases: “Social capacity” and “Emergency preparedness, response and recovery” (Figure 11.b and f, whereas it is a spatial outlier for “Planning, regulation and mainstreaming risk mitigation” (Figure 11.d). Furthermore, AlMakhfeya is characterized by a low-low value for “Planning, regulation and mainstreaming risk mitigation” and “Emergency preparedness, response and recovery” (Figure 11.d, f). Specifically, these two districts show positive spatial association (cluster), i.e., the resilience indices at these locations are more similar to their neighbours. In general, clusters occur in the South-Western regions, while the Eastern Area is a location of spatial outliers for all the considered themes. Finally, the Downtown area does not apparently present, for five over six themes, any spatial correlation with the surrounding neighbourhoods.

Finally, a validation analysis of these results with the multi-level ANOVA test, which is also a nested model and sometimes called the two-ways ANOVA, was conducted. This method belongs to the group of multilevel modelling methods with repeated measures, which are occasionally nested within cases. The multi-level ANOVA test results showed that the p-value is less significant in more cases for the selected variables. This speaks about significant statistical effects, which indicates to the relationships between considered variables. This approach is also in line with the work of Arcaya et al. (2012), who proposes different approaches for data analysis and interpretation for the cases when multiple sources of area-clustering are present. This approach refers to dependence and autocorrelation and allows interpretation of results from multi-level and spatial perspectives.

7 Conclusions

This study presented a detailed assessment of the seismic social vulnerability level of a particularly complex case study, Nablus, in Palestine, which faces both natural hazard risk and political issues. Different methodologies (holistic and statistic) have been employed to a significantly large and complete sample of data, obtained specifically through local questionnaires. Nablus is promoting disaster risk management and reduction only from the last decade, many times based on the collaboration between local researchers and European institutions. The presented techniques revealed themselves useful to evaluate the status, gaps and current achievements of key resilience dimensions in the city. Particularly, the Scorecard Approach provided a comprehensive diagnosis and denoted, for this case, a low level of resilience of the city and lacking strategies in DRR.

The SASPARM 2.0 initiative is enhancing the local capacities with training for fostering good practice in risk prevention and preparation. Indeed, several activities have been and will be developed in Nablus and in Palestine to contribute to the dissemination of guidelines and policies to respond to earthquake events. Different vulnerability types require specific evaluation to reduce both the physical and the socioeconomic susceptibility. In this sense, the youngest layers of the population, who will be the new generation of civil protection volunteers, need to implement processes for the elaboration of vulnerability mitigation measures.

However, in the light of the results herein presented, improvements should be foreseen, especially in local centres for emergency response and plans. In order to assure informed decisions, results about risk scenarios and planning should be communicated in an appropriate manner to the population, promoting effective systems of information for disaster risk

management. Moreover, society should be involved in the decision processes through mechanisms of participation. On the other hand, local administrators' results show a low capacity of the administration staff itself in risk management. For this reason, administration should strengthen the regulation for the implementation of seismic requirements of public infrastructure and propose incentives for the private one. In addition, special training for municipality personnel could be a key measure for improvement of the resilience of society.

Finally, the performed spatial analysis provided a basis for a spatially explicit social policy that may be able to address the needs of individual communities in a more effective manner. The improvement of emergency management may recognize and take into account the variability in the vulnerable population's location to develop place-based emergency plans accordingly. This will cater for the establishment of priorities for more in-depth analysis, as well as allocation of funds and development of emergency and disaster management programs more effectively.

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Appendix

Evaluation of SOCIAL VULNERABILITY – QUESTIONNAIRE

Place of Residence	_____								
Are you a refugee?	<input type="checkbox"/> Yes				<input type="checkbox"/> No				
Gender	<input type="checkbox"/> Male				<input type="checkbox"/> Female				
Age	<input type="checkbox"/> 20 – 30	<input type="checkbox"/> 30 – 40	<input type="checkbox"/> 40 – 50	<input type="checkbox"/> 50 – 60	<input type="checkbox"/> More than 60				
Education Level	<input type="checkbox"/> Illiterate	<input type="checkbox"/> Elementary	<input type="checkbox"/> Preparatory	<input type="checkbox"/> Secondary	<input type="checkbox"/> College	<input type="checkbox"/> College	<input type="checkbox"/> B.A.	<input type="checkbox"/> Postgraduate	
Working Status	<input type="checkbox"/> Employed		<input type="checkbox"/> Unemployed		<input type="checkbox"/> Housewife		<input type="checkbox"/> Student		<input type="checkbox"/> Retired
Occupation	_____								
Working Sector	<input type="checkbox"/> Public		<input type="checkbox"/> Private			<input type="checkbox"/> NGOs			

N° family members					
Monthly Income	<input type="checkbox"/> 0 – 1500 NIS	<input type="checkbox"/> 1500 – 2500 NIS	<input type="checkbox"/> 2500 – 3500 NIS	<input type="checkbox"/> 3500 – 4500 NIS	<input type="checkbox"/> More than 4500 NIS

1.1 THEME: Awareness and Advocacy

WHAT IS THE LEVEL OF AWARENESS AND KNOWLEDGE OF EARTHQUAKE DISASTER RISK?

Question	Answers				
Do you think that Palestine is prone to a destructive earthquake in the near future?	Yes	No	Not aware		
If yes, in your opinion, how many people in your neighborhood are concerned about a destructive earthquake?	Almost all	Many	A few	None	Not aware
In case an earthquake happens, do you know how to behave and protect yourself and your family?	Yes	No	Not aware		
Are brochure and flyers available for people to inform themselves about risk reduction?	Yes, highly available in different parts of the neighborhood	Yes, somewhat available in different parts of the neighborhood	Yes, but are available only upon request	No , are not available	Not aware
Have you ever participated in trainings activities about earthquake safety and preparedness (e.g. demonstrations of evacuation plans)?	Often and regularly	Sometimes	Rarely	Never	Not aware
In case an earthquake happens,	Yes	No	Not aware		

Question	Answers		
do you know any shelter nearby to protect yourself?			

1.2 THEME: Social Capacity

WHAT ARE THE CAPACITIES OF THE POPULATION TO EFFICIENTLY PREPARE, RESPOND AND RECOVER FROM A DAMAGING EARTHQUAKE?

Question	Answers				
Are healthcare and social assistance services like clinics available for vulnerable groups (e.g. children, elders, disabled)?	Yes, many services exist	Yes, some services exist	Yes, few services exist	No services exist	Not aware
What level of interaction exist between people in your neighborhood?	Most people know each other well	Some people know each other well	Few people know each other	People do not know each other at all	Not aware
What level of interaction exist between people in your neighborhood and refugee camps?	People from refugee camps usually is contact with the neighborhood	People from refugee camps sometimes is contact with the neighborhood	People from refugee camps rarely is contact with the neighborhood	People from refugee camps is not in contact with the neighborhood	Not aware
What is the level of social integration of minorities (e.g. different religions) within the neighborhood?	High	Moderate	Low	Almost none	Not aware
Are special programs in place to protect historic buildings and cultural heritage?	Many programs are in place	Some programs are in place	Few programs are in place	No preservation programs exist	Not aware
What is the degree of social integration considering	High	Moderate	Low	Almost none	Not aware

Question	Answers				
different economic level within the neighborhood?					
What is the level of access of your neighborhood's population to electricity, gas and clean water?	Widespread access	Some access	Limited access	Very little access	Not aware
How many people in your neighborhood have at least a primary education?	Almost all	Many	A few	None	Not aware
How many women in your neighborhood have at least a primary education?	Almost all	Many	A few	None	Not aware
Are women involved in voluntary associations?	Highly	Moderately	Lowly	Almost none	Not aware

1.3 THEME: Legal and Institutional Arrangements

HOW EFFECTIVE ARE MECHANISMS TO ADVOCATE EARTHQUAKE RISK REDUCTION IN YOUR QUARTER?

Question	Answers				
To your knowledge, are regulations and ordinances available for earthquake safety and risk reduction?	Yes		No		Not aware
If yes, are these regulations and ordinances effective?	Yes, most regulations are in use	Yes, but only some regulations have been implemented	Yes, but very few regulations have been implemented	No, they are not in use	Not aware
How much confidence do you have in municipality to prepare for,	High	Moderate	Low	Almost none	Not aware

Question	Answers				
respond and recover from a damaging earthquake?					
How much confidence do you have in governmental association like civil defense to prepare for, respond and recover from a damaging earthquake?	High	Moderate	Low	Almost none	Not aware
How much confidence do you have in non – governmental Institutions like Red Crescent to prepare for, respond and recover from a damaging earthquake?	High	Moderate	Low	Almost none	Not aware

1.4 THEME: Planning, Regulation and Mainstreaming Risk Mitigation
WHAT IS THE PERCEIVED LEVEL OF COMMITMENT AND MAINSTREAMING OF DISASTER RISK REDUCTION THROUGH REGULATORY PLANNING TOOLS?

Question	Answers				
To your knowledge, are safety areas available to protect yourself in case of earthquake?	Yes		No		Not aware
If Yes, are these areas recognized and implemented in your neighborhood?	Yes, in most cases	Yes, but only in some cases	Recognized, but not implemented	No	Not aware
Are earthquake resistant building construction codes enforced in the city?	Yes, in residential essential cases (schools)	Yes, in some residential essential cases (schools)	Yes, recognized but not enforced	No, codes do not exist	Not aware
If you would like to	Yes, for	Yes, for	Yes, for few	No,	Not aware

Question	Answers				
retrofit your house, are public incentives available?	most private buildings	some private buildings	private buildings	incentives do not exist	
Do you have an earthquake insurance for your house?	Yes		No		Not aware
To your knowledge, how many people in your neighborhood have an earthquake insurance for their house?	Many	Some	A few	Almost none	Not aware

1.5 THEME: Emergency Preparedness, Response and Recovery
WHAT IS THE LEVEL OF effectiveness AND competency OF DISASTER management including mechanisms for response and recovery?

Question	1	2	3	4	5
Do people in your neighborhood store food, water and fuel that will be available for more than one week following an earthquake?	Many	Some	A few	Almost none	Not aware
Do you have an emergency shelter such as hospital, Red Crescent, Civil Defense or any other center close to your neighborhood?	Yes, fully operational	Yes, partially operational	Yes, but rarely operational	No, are not available	Not aware
Are funds available for emergency preparedness, response and recovery operations?	Yes, directly available	Yes, funds are available with legal restrictions	Yes, funds are planned for but are not available	No, funds are not available	Not aware
Do volunteers and/or community organizations exist for emergency?	Many	Some	Few	Almost none	Not aware
Are volunteers trained and coordinated for emergency and	Yes, efficiently trained and coordinated	Yes, sufficiently trained and coordinated	Yes, but volunteers are rarely trained and	No, volunteers are not trained and	Not aware

Question	1	2	3	4	5
recovery?			coordinated	coordinated at all	
To your knowledge, do people in your neighborhood actively participate in voluntary association or in voluntary works?	Many	Some	Few	Almost none	Not aware
Do health and sanitation services exist for post-earthquake emergency?	Yes, services exist and regularly updated	Yes, services exist and sufficiently implemented	Yes, services exist , but not implemented	No, services do not exist	Not aware
Do search and rescue services exist for post-earthquake emergency?	Yes, services exist and regularly updated	Yes, services exist and sufficiently implemented	Yes, services exist , but not implemented	No, services do not exist	Not aware
Do shelters and food provision exist for post-earthquake emergency?	Yes, services exist and regularly updated	Yes, services exist and sufficiently implemented	Yes, services exist , but not implemented	No, services do not exist	Not aware

1.6 THEME: Critical Services and Public Infrastructures Resilience

WHAT IS THE LEVEL OF resilience of critical services to disasters?

Question	1	2	3	4	5
Are reinforcement and retrofitting measures in place for critical infrastructure such as hospitals and schools?	Yes, measures exist for most critical infrastructure	Yes, measures exist for some critical infrastructure	Yes, measures exist for few critical infrastructure	No, measures do not exist	Not aware
Do exist specific non-structural improvements like extra generator for electricity and spare pumps for water supply systems to reduce seismic risk in health facilities?	Yes, improvements exist for most health facilities	Yes, improvements exist for some health facilities	Yes, improvements exist for few health facilities	No, measures do not exist	Not aware
Do exist specific	Yes,	Yes,	Yes,	No,	Not

Question	1	2	3	4	5
non-structural improvements like fixing and securing bookshelves or apply anti-shattering film on normal sheet glass to reduce seismic risk in schools?	improvements exist for most schools	improvements exist for some schools	improvements exist for few schools educational facilities	measures do not exist	aware
Does your neighborhood have a plan for the repair of critical lifelines in the aftermath of a damaging earthquake event (e.g. water, electricity, telephone)?	Yes, plan exists and regularly updated	Yes, plan exists and sufficiently implemented	Yes, plan exists , but not implemented	No, plan does not exist	Not aware

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