

**Research Paper**

Assessing the Resilience Level of Urban Neighborhood Against Earthquakes

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ABSTRACT

During the recent decades, the rapid growth of urban settlements has increased the risk of disasters. Therefore, improving the resilience of urban areas to natural hazards is essential. This article aims to evaluate earthquake resilience at local level by assessing and analyzing physical and social criteria. It proposes practical interventions at the micro, meso, and macro levels. A hybrid and field-based approach was applied for assessing the resilience of neighborhood against earthquakes as following steps: (1) To identify key components and indexes of physical and social resilience; (2) To determine tree structure for neighborhood resilience factors; (3) Field survey and data collection; (4) AHP analysis to determine the weights; (5) Performing GIS analysis to assess the earthquake resilience of the neighborhood. The proposed approach was applied in Jalaliyeh Neighborhood, Tehran, Iran, as a case study. The results reveal a spatial variation in the neighborhood's earthquake resilience, with lower levels of resilience in the western parts compared to the eastern parts. The neighborhood's average social resilience level is thirty percent and 'low', whereas its physical resilience level is 'moderate' with amount of fifty-one percent. The neighborhood's resilience is distributed as follows: thirty-four percent very high, ten percent high, sixteen percent moderate, twenty-four percent low, and sixteen percent very low. The quantitative-qualitative approach, indicators, and criteria are applicable to assess the earthquake resilience of various urban neighborhoods, especially in similar contexts. Disaster risk managers can utilize this approach as a decision-support tool for improving the resilience and allocating the necessary funds accordingly.

Keywords:

Resilience; Earthquake; Disaster; Urban neighborhood; Jalaliyeh; Tehran

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1. Introduction

Rapid urbanization makes different challenges to humanity, and the growing population in vulnerable urban fabrics increasingly exposes people to more frequent and substantial hazards (Bottero et al., 2020). To this end, academics and practitioners have noticeably focused on how to reduce disaster risk more efficiently in the context of disaster management cycle (Badarin, 2023). However, there are some criticisms of cyclic concept of Disaster Risk Management (DRM) in recent years, due to its overly simplistic approach to conceptualizing and representing disasters that generally begin with an event and ultimately lead to many consequences (Bosher et al., 2021).

In recent decades, disaster risk management approaches have changed from 'reducing vulnerability' to 'increasing resilience' (Fekete et al., 2014; Saja et al., 2020). As a subsequent, disaster resilience has become one of the most significant issues in disaster research. In this regard, various models and frameworks with methods such as quantitative, qualitative, inductive, and deductive have been developed to assess the resilience level to natural disasters (Karakoc et al., 2019).

Despite the increasing importance and interdisciplinary use of resilience, no standard definition has been presented for this concept, so far (Pfefferbaum et al., 2013). Bruneau et al. (2003) pointed out that disaster resilience is the capacity of social units to reduce disaster risk and to carry out recovery activities, optimally. Resilience is often used to show the capacity to bounce back, bounce back better, and bounce forward after disorder (Folk, 2016). However, some researchers, such as Holling & Gunderson (2002), and Carpenter et al. (2005), define resilience as the ability of systems to respond to change, adapt and transform. A similar viewpoint of resilience is offered by Meerow & Newell (2019), who consider it as a dynamic concept consisting of inherent and adaptive abilities. In addition, disaster resilience is the return rate to equilibrium that has been achieved after a crisis (Pearson & Pelling, 2015).

Another recent trend in disaster studies is the assessment of urban resilience. Urban resilience refers to the ability of an urban system and its

ecological, physical and social networks to maintain or rapidly return to the desired functions in the face of a disaster or shock (Ribeiro & Goncalves, 2019). Additionally, urban resilience measures are capacities to survive, adapt, and absorb the consequences of a given situation (Sharifi & Murayama, 2013). The existence of urban resilience is thought to be influenced by a number of factors, including city dynamics, urban complexity, vulnerability, exposure, density and growth of cities (Kwok et al., 2018).

Even though disaster resilience has been extensively studied in urban contexts, the question on how to bridge the gaps between theory and practice in relation to resilience at the local level has been rarely studied; while impacts of destructive disasters (e.g., earthquakes) unfold the importance of resilience assessment at the micro-levels such as neighborhoods (Burton, 2012).

In this article, local level and neighborhood scales are selected and investigated to evaluate the neighborhood resilience against earthquakes, based on the developed conceptual model and inferred indicators. Jalaliyeh neighborhood that is located in the center of Tehran, Iran, was selected as a case study to evaluate the resilience level against earthquakes. The main reason for choosing this neighborhood is its strategic location, centralization and the mixed land use in or around it. Afterward, by assessing the resilience level of this neighborhood, appropriate interventions at micro, meso and macro levels are suggested to improve earthquake resilience.

2. Theoretical Framework

Neighborhood as a physical place in which social interactions is formed plays significant roles in increasing resilience against disasters. However, resiliency has different layers and scales (Figure 1). Therefore, it is necessary to localize and to recognize root causes of vulnerability to address the normal or pre-disaster conditions in order to reduce the effects of probable future disasters on the community (Coulton et al., 2013).

In order to assess the earthquake resilience at neighborhood level, key components and indexes affecting resilience should be identified and derived based on the neighborhood characteristics,

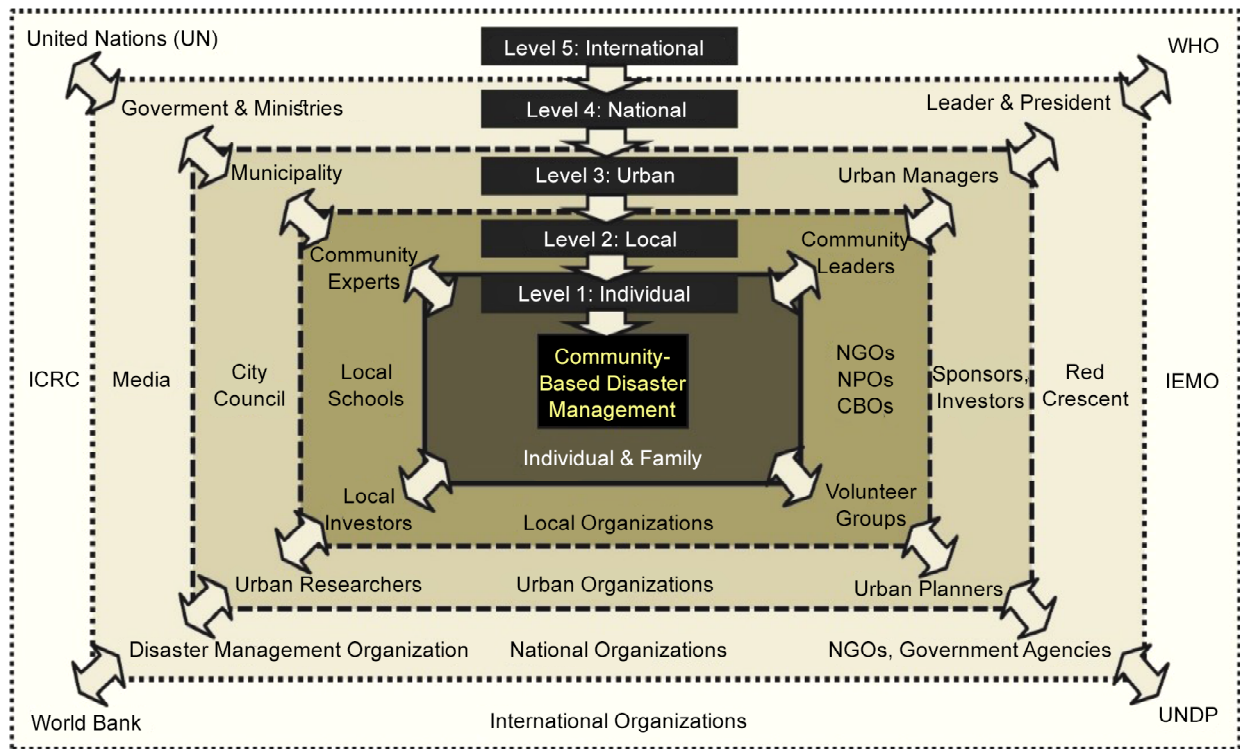


Figure 1. Levels and scales of disaster resilience (the authors).

technical literature, and theoretical foundations. To address resilience, Norris et al. (2008) have identified three key components of cities: (1) form and pattern, (2) access and urban function, and (3) service and infrastructure. Furthermore, according

to Mayunga 2009, electricity, water, sanitation, buildings, land use, and landscape are all considered as physical resilience indicators. Other researchers presented some additional resilience indicators which is demonstrated in Figure (2). This figure presents

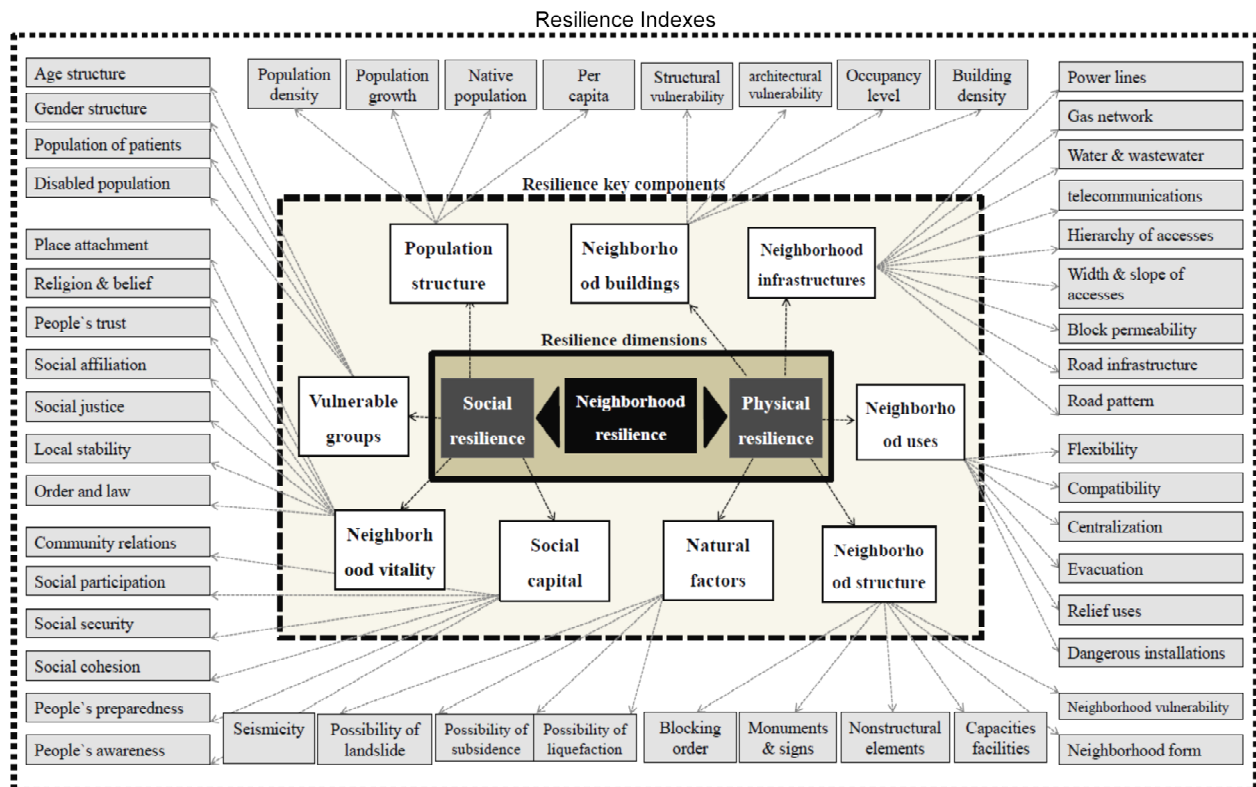


Figure 2. Conceptual framework (based on Renschler, 2013; Doyle et al., 2015; Khazai et al., 2015; Aslani & Amini Hosseini, 2024).

key components and indexes of physical and social resilience according to the literature review and theoretical foundations. Accordingly, the neighborhood resilience can be evaluated after identifying and weighing these indicators.

3. Research Methodology

The proposed process for assessing the resilience level at neighborhood level uses a multi-stage approach through the following steps, as depicted in Figure (3).

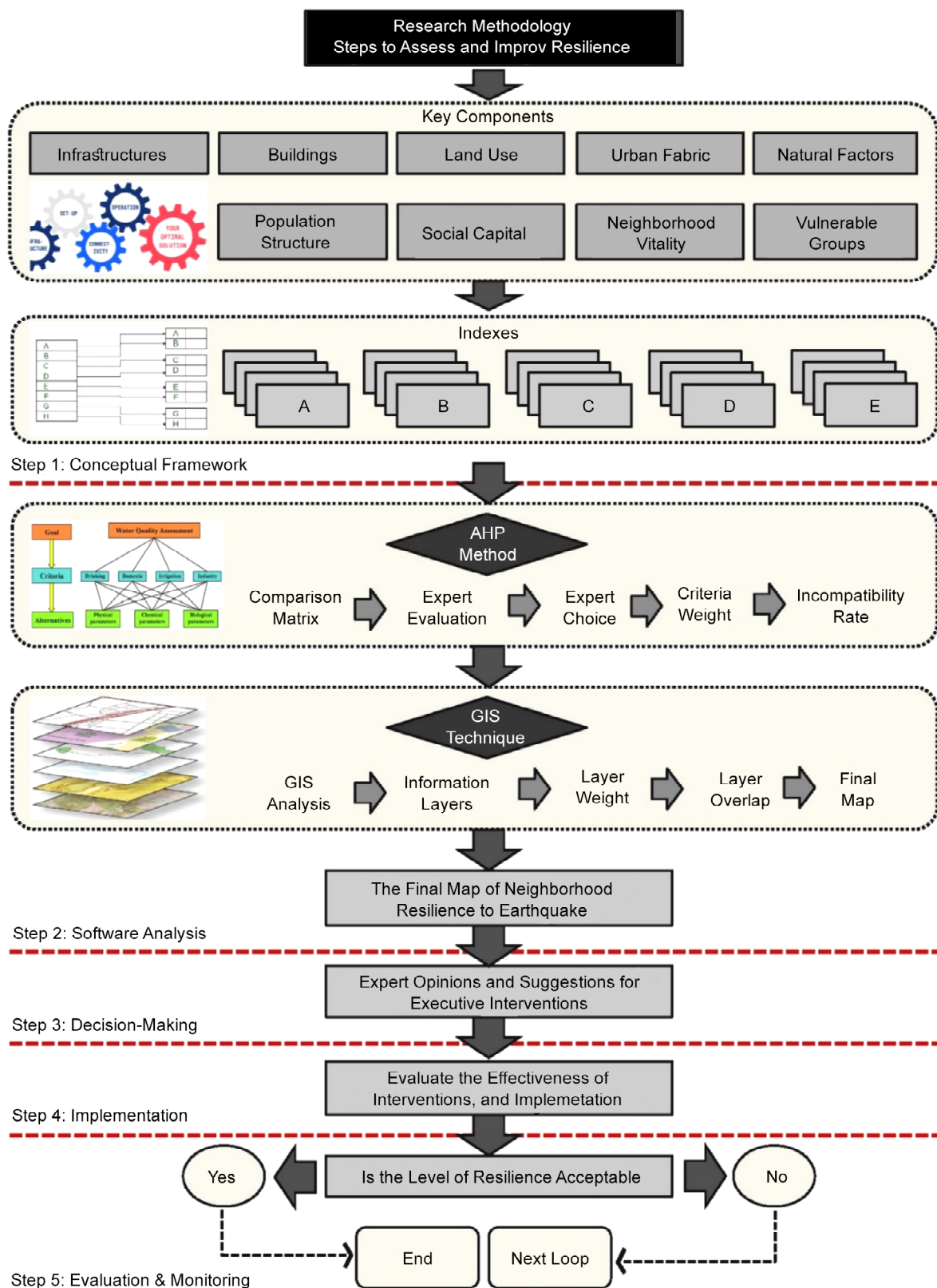


Figure 3. Research methodology for assessing the resilience level of the neighborhood.

- a) To identify key components and indexes of physical and social resilience;
- b) To determine tree structure for neighborhood resilience factors;
- c) Field survey and data collection;
- d) AHP analysis to determine the weights of the factors;
- f) Conducting GIS spatial analysis to assess the existing resilience of the neighborhood.

In order to apply the proposed approach for resilience assessment at this neighborhood, at first a questionnaire was prepared to be filled by experts to weigh and prioritize the indices depicted in Figure (2). Thirty-six experts answered this questionnaire, and its reliability was approved by the Cronbach's Alpha coefficient using the SPSS software. The Cronbach's Alpha value was 0.82, which indicates the expert questionnaire's external validity or relatively good reliability. In the next step, the weight of the indexes was calculated using the Expert Choice and AHP. In other words, Expert Choice was used as a decision-making software and implemented the Analytical Hierarchy Process (AHP) based on the inferred multi-criteria indicators.

In addition to the experts' questionnaire, another questionnaire was prepared for the residents of Jalaliyeh neighborhood based on the indexes listed in Figure (2). The questionnaire was designed using the Likert scale and a scale of 1 to 5 (very low, low, moderate, high, very high). The statistical population consists of residents of the Jalaliyeh neighborhood in the age of 20 to 65 years, regardless of gender or specific groups. According to Cochran's formula, the sample size is 270 people with an error level of 5% and 95% confidence level. 110 male and 160 female respondents were randomly selected. After distributing and analyzing the questionnaires, each index in the neighborhood was evaluated using SPSS and statistical tools and methods including average, mean, regression and correlation. In addition to statistical analysis, field surveys based on observations were conducted from the neighborhood, and the required maps were updated and prepared, which are presented in the following sections.

This study employed the Analytic Hierarchy Process (AHP) to calculate the weights of various

indices for prioritization. Then the weights of the layers have been multiplied by the standard indicators. AHP analysis was conducted to determine the weights of the factors. Based on the decision hierarchy capability, AHP gives a percentage distribution of decision points. The method was applied in four stages. First, components and criteria were identified. Following that, binary comparison matrices were created between them. In the third stage, weight distribution was determined for each factor. Fourth stage was conducted to measure the consistency of judgments in comparison with the samples.

4. Case Study and Implementation of the Process

Tehran, the Capital of Iran, with a population of over 10 million, is one of the most vulnerable cities to earthquakes (Chavoshy et al., 2018). The city is subjected to high seismic risk based on seismic hazard analysis and vulnerability of existing buildings (Amini Hosseini et al., 2014). To evaluate the applicability of the deduced resilience indicators which are introduced in this paper, one of the neighborhoods in district 6 of Tehran, known as Jalaliyeh, was chosen as a case study. The location map and aerial photo of the selected neighborhood are shown in Figure (4). As depicted in Figure (4), it is located in the central part of Tehran. Moreover, green and open spaces are in the west of the neighborhood and urban buildings and infrastructures are in the eastern side. This neighborhood was selected as a case study for assessing the neighborhood resilience to possible earthquake, based on the current conditions. After the resilience assessment of the neighborhood, appropriate practical interventions at three levels of micro, meso and macro are suggested for improving earthquake resilience.

This neighborhood was selected due to its high seismic risk and existing different land uses such as residential, official, commercial and service spaces as well as sensitive land uses like Ministry of Agriculture, Water Organization, Mehr Hospital, Pars Hospital, Sasan Hospital, Carpet Museum, and Disaster Management Headquarters of District 6 of Tehran Municipality (Figure 4). Another reason for choosing this neighborhood for earthquake



Figure 4. Jalaliyeh neighborhood location map in Tehran (Up) (based on JICA 2000 and Google Earth Map 2024), some important uses of Jalaliyeh neighborhood including (a) Sasan hospital, (b) Pars hospital, (c) Imam Khomeini hospital, (d) General justice of Tehran province, (e) Carpet Museum, (f) Laleh self-employed bazaar, (Down).

resilience assessment is its strategic features, and every day many people come to this neighborhood for different activities. In addition, in case of emergency after an earthquake, most of the facilities located in this neighborhood should be mobilized to provide necessary services to the victims. On the other hand, there is no contingency plan for managing the necessary affairs of residents and wandering population after an earthquake. Therefore, it appears that in order to manage earthquake consequences, it is necessary to evaluate and improve earthquake resilience at this neighborhood.

Table (1) shows the key components and indicators of neighborhood resilience and their weights.

Following the previous steps, a comprehensive classification of physical and social resilience indicators was prepared. A sample of this classification is presented in Table (2).

For example, building density is one of the most important resilience indicators, and buildings with a lower density are more resilient. Accordingly, GIS spatial analysis capabilities were utilized to generate the required maps based on the weighted layers.

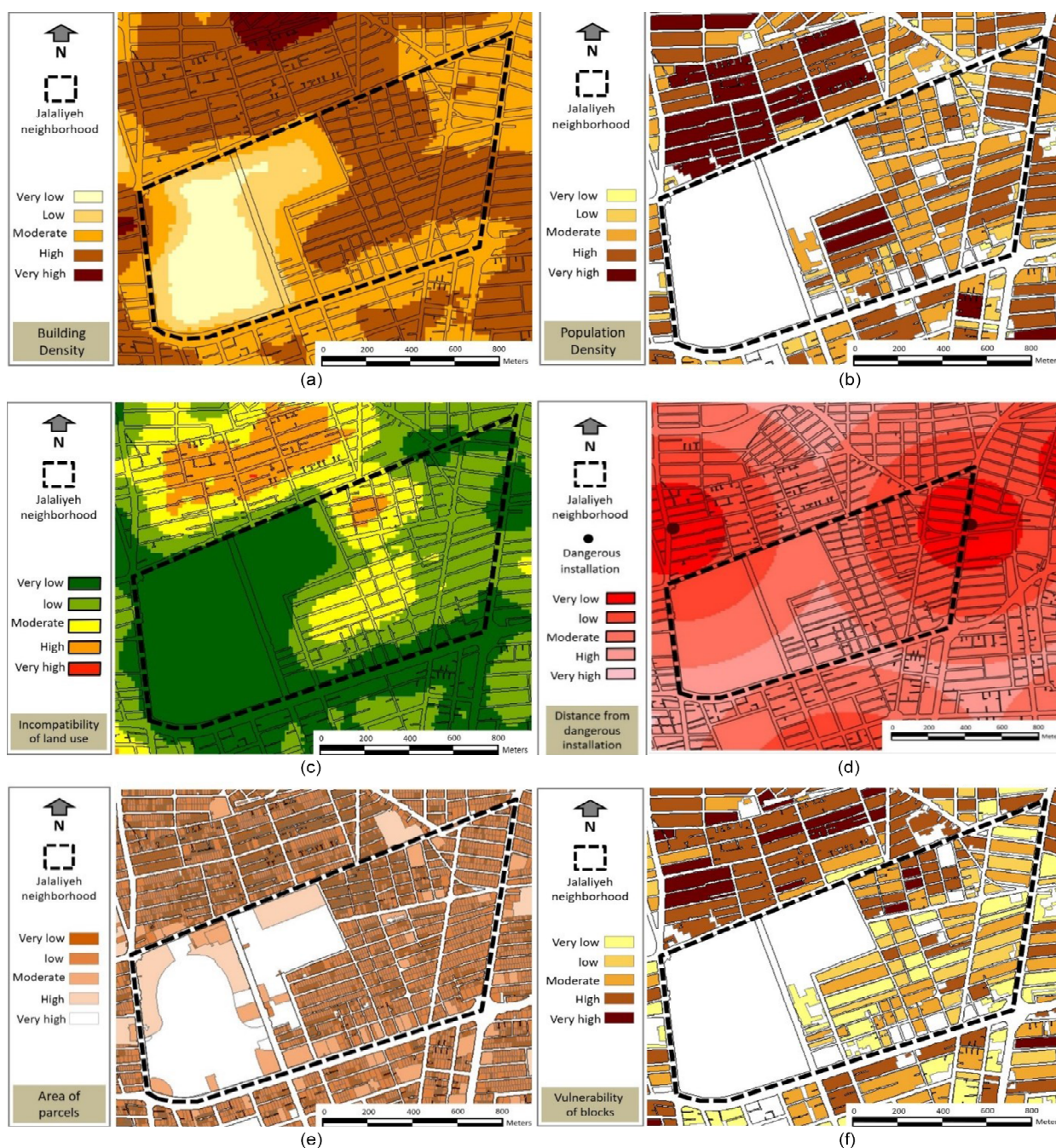
Some examples of maps are presented in Figure (5). Figure (5a) illustrates how the density of buildings is lower in the western area of the selected neighborhood than in the east, which means the resilience level in the west is higher than the east. The population density is another

Table 1. Weighting the dimensions, components and indicators of neighborhood resilience against earthquakes (the authors).

Resilience Dimensions	Key Components	Indicators	Indicators' Weights	Total Weights
Social resilience W = 0.4	Demographic structure of the neighborhood W = 0.24	Per capita and household size	W=0.2	W=0.019
		Percentage of local population	W=0.24	W=0.023
		Population growth rate	W=0.23	W=0.022
		Population density	W=0.33	W=0.032
	Vulnerable groups of the neighborhood W = 0.27	Gender structure of the neighborhood (percentage of female population)	W=0.23	W=0.025
		Age structure of the neighborhood (under 6 years and over 65 years)	W=0.32	W=0.035
		The percentage of disabled people in the neighborhood	W=0.26	W=0.028
		The percentage of patients in the neighborhood	W=0.19	W=0.02
	The vitality of the neighborhood W = 0.21	Place attachment and identity of the neighborhood	W=0.16	W=0.014
		The status of religion, beliefs and values in the neighborhood	W=0.13	W=0.01
		The level of trust in people	W=0.19	W=0.016
		The status of neighborhood independence	W=0.17	W=0.014
	Social capital W = 0.28	The situation of stability and justice in the neighborhood	W=0.16	W=0.014
		The level of law and order in the neighborhood	W=0.19	W=0.016
		The level of preparedness and awareness against disasters	W=0.22	W=0.025
		The level of social solidarity	W=0.19	W=0.021
	Neighborhood buildings W = 0.22	The level of social security	W=0.19	W=0.021
		The level of social participation	W=0.21	W=0.024
		The level of social communication	W=0.19	W=0.021
		The effect of building architecture on vulnerability	W=0.26	W=0.034
Physical resilience W = 0.6	Neighborhood buildings W = 0.22	Building density	W=0.25	W=0.033
		Graining, grading and occupancy area	W=0.23	W=0.031
		Vulnerability of structure	W=0.26	W=0.034
	Neighborhood infrastructures W = 0.24	Vulnerability of gas network	W=0.12	W=0.018
		Vulnerability of power line	W=0.12	W=0.018
		Vulnerability of water and wastewater network	W=0.11	W=0.017
		Vulnerability of communications and telecommunications	W=0.11	W=0.017
	Neighborhood uses W = 0.17	Systematization of passages and hierarchy of accesses	W=0.11	W=0.017
		Width and slope of passages, accesses and intersections	W=0.11	W=0.017
		Geometry and pattern of passages and accesses	W=0.1	W=0.015
		Permeability of blocks	W=0.11	W=0.016
	Urban fabric and structure W = 0.2	Vulnerability of road infrastructure	W=0.11	W=0.016
		Flexibility of uses	W=0.11	W=0.011
		Compatibility of uses	W=0.11	W=0.011
		Centralization of uses	W=0.11	W=0.011
	Natural factors of neighborhood W = 0.17	Diversity of uses	W=0.11	W=0.011
		Access to relief and security services	W=0.16	W=0.016
		Suitable uses for evacuation and emergency housing	W=0.14	W=0.014
		The possibility of sustaining livelihood and business after the earthquake	W=0.12	W=0.012
	Urban fabric and structure W = 0.2	Hazardous facility risk	W=0.14	W=0.014
		Vulnerability of neighborhood fabric	W=0.19	W=0.023
		Form and pattern of neighborhood	W=0.17	W=0.021
		Neighborhood block system	W=0.17	W=0.02
	Natural factors of neighborhood W = 0.17	Vulnerability of landmarks and signs	W=0.15	W=0.016
		Vulnerability of furniture and nonstructural elements	W=0.12	W=0.015
		Facilities and capacities of the neighborhood	W=0.2	W=0.024
		Seismic condition of the neighborhood	W=0.52	W=0.053
	Natural factors of neighborhood W = 0.17	The possibility of landslides due to earthquakes	W=0.16	W=0.015
		The possibility of subsidence due to earthquakes	W=0.16	W=0.015
		The possibility of liquefaction due to earthquakes	W=0.16	W=0.015

Table 2. Sample classification of physical and social resilience indicators of the neighborhood (Lee, 2020; Peek et al., 2020).

Resilience dimensions	Resilience Index Sample	Index Category	Earthquake Resilience	Resilience Level
Physical Resilience	Building Density	Less than 20%	Very high	0.8-1
		20-40%	High	0.6-0.8
		40-60%	Moderate	0.4-0.6
		60-80%	Low	0.2-0.4
		More than 80%	Very low	0-0.2
Social Resilience	Population Density	Less than 150 people per hectare	Very high	0.8-1
		150-300 people per hectare	High	0.6-0.8
		300-450 people per hectare	Moderate	0.4-0.6
		450-600 people per hectare	Low	0.2-0.4
		More than 600 people per hectare	Very low	0-0.2

**Figure 5.** Samples of prepared information layers, (a) Building density, (b) Population density, (c) Incompatibility of land use, (d) Distance from dangerous installation, (e) Area of parcels, (f) Vulnerability of blocks, (g) Final map of the earthquake resilience.

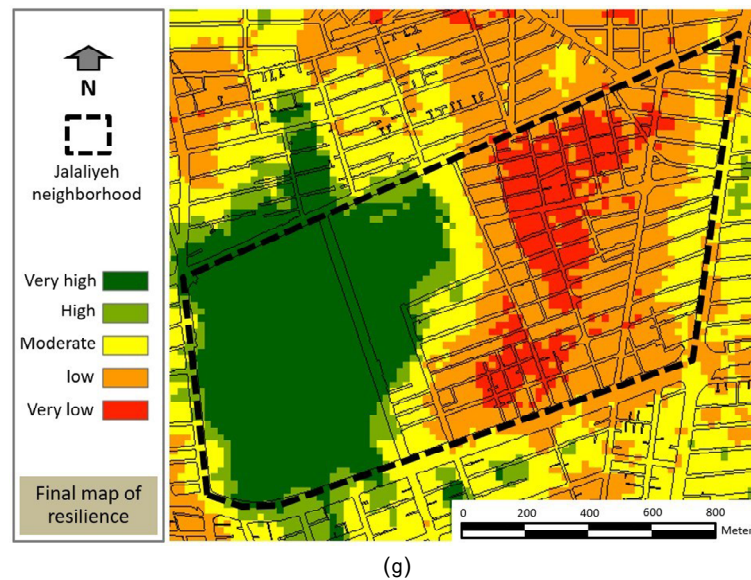


Figure 5. Continue.

important indicator of neighborhood resilience. Figure (5b) presents the population density of Jalaliyeh neighborhood. In the east of the neighborhood, the population density is higher due to its dominant residential land use, but in the west, it is lower due to its dense green spaces. In general, a lower population density indicates greater neighborhood resilience. To generate the final earthquake resilience map, standardized GIS layers were multiplied by the weights of the indicators (Table 1). As a final step, the generated maps were overlaid according to their weight importance to produce the final result as shown in Figure (5g).

According to the analysis, five levels of earthquake resilience can be identified, varied from 'very low' to 'very high' in all information layers. Finally, as shown in Figure 5-g, the western zones of the neighborhood have a higher level of resilience in comparison with the eastern parts. Based on the information layers, field surveys and conducted assessments, it appears that the following factors contribute to the low resilience of the eastern parts of the neighborhood:

- Higher population and buildings' density;
- Narrow roads with higher risk of blockage by debris;
- Lack of proper access to parks and urban open spaces;
- Existing weak tall buildings and architectural vulnerabilities;
- The presence of vulnerable and dangerous nonstructural elements.

It should be noted that resilience indicators are divided into two groups: "quantitative" and "qualitative" (Nguyen and Akerkar, 2020). Some resilience indicators such as "population density" (Figure 5b) are quantitative and can be expressed numerically. For example, population density, which is the ratio of population to area, is represented by the unit "people per hectare". However, some other indicators of neighborhood resilience, such as "place attachment" are qualitative and cannot be categorized by numbers. Place attachment is the emotional bond between person and place, as well as the relationship between people and environment.

Place attachment and other qualitative indicators can be "very high" (0.8-1), "high" (0.6-0.8), "moderate" (0.4-0.6), "low" (0.2-0.4) or "very low" (0-0.2) and are divided into five categories based on the Likert scale. The evaluated qualitative indicators of resilience in Jalaliyeh neighborhood include place attachment, identity, beliefs, justice, regularity, participation, communications, solidarity, security and awareness. As displayed in the spider graph (Figure 6), in Jalaliyeh neighborhood the amount of security is high (0.9) and the amount of regularity is low (0.3). Considering the area of the polygon and the weight of the indicators, the level of social resilience of the neighborhood is "low".

5. Proposed Interventions to Improve Resilience

Once Jalaliyeh neighborhood's level of earthquake resilience has been assessed by using a hybrid

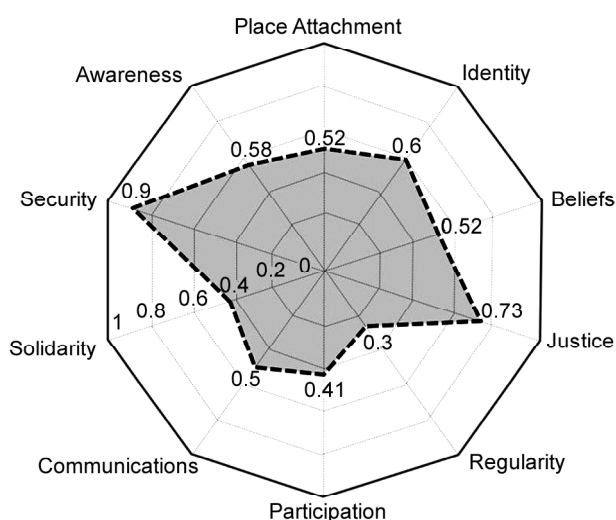


Figure 6. Spider graph of evaluating social resilience level of Jalaliyeh Neighborhood against earthquake (the authors).

approach, it is crucial to propose interventions to enhance the neighborhood's resilience. Proposed interventions can be implemented in three levels: micro, meso, and macro.

As shown in Table (3), on the micro-level, short-term solutions (up to 3 years) should be identified and implemented by local governmental institutions, residents, community-based organizations

(CBOs), and non-governmental organizations (NGOs). Despite the relatively low cost of these interventions compared with other levels, it seems that their impact on neighborhood resilience can be significant since they focus on physical and social parameters at local level.

Interventions at the meso level address medium-term solutions that can be implemented within three to seven years. At this level, local governments (municipalities), disaster management, and civil organizations (e.g., service providers) have an essential role to play. Moreover, interventions at meso-level are typically more costly than activities at the micro-level; therefore, the government should allocate sufficient resources for their implementation. Finally, macro-level interventions can last for more than seven years, and they require the collaboration of policy-makers, the government, and in some cases, international organizations. Interventions at this level are inevitably complex and costly. Table (3) presents the key activities that can be implemented in Jalaliyeh neighborhood to improve resilience at these three levels of intervention.

Table 3. Three levels of proposed interventions for improving resilience at Jalaliyeh neighborhood (the authors).

Level	Time	Executer	Proposed Solution
Micro level	0-3 years	Local governmental institutions, residents, CBOs and NGOs	Establishment and development of community-based disaster risk management groups
			Public awareness activities at mosques and schools with the aim of promoting preparedness level
			Improving necessary emergency facilities and equipment for response activities, preparing safe evacuation spaces and emergency shelters at Laleh Park
			Reducing non-structural vulnerabilities
			Organizing public drills and exercises
Meso level	3-7 years	Municipalities, service providers, disaster management organizations	Aggregation of fine-grained blocks and parcels in the northeast and south of the neighborhood
			Enforcement of earthquake-resistant design codes and standards and improving the inspection system to secure design-compliant building act
			Upgrading safety and response capacities by establishing new emergency centers
			Retrofitting vulnerable infrastructures and lifelines
			Enforcement of disaster insurance
Macro level	more than 7 years	National government, policy-makers, international institutions	Planning for controlling the population density
			Dedicating funds/loans for urban redevelopment and retrofitting private buildings
			Strengthening or renovating three vulnerable blocks in the neighborhood
			Development of open and green space in the eastern parts
			Widening the roads to reduce the risk of road blockage and increasing permeability
			Land readjustment and relocating or changing problematic land-uses
			Developing Public-Private-Partnership (PPP) system

6. Conclusion

This article outlines an approach for evaluating earthquake resilience at the local level, using both qualitative and quantitative social and physical indicators. Then, a hybrid approach was applied in Jalaliyeh neighborhood, Tehran, Iran. This approach is applicable for evaluating the resilience level of every neighborhood against earthquakes in similar contexts, especially in developing countries. At first, the factors of physical and social resilience at neighborhood level were determined to evaluate the earthquake resilience. Then, their importance and priority were evaluated, using questionnaire-based survey and AHP technique.

Subsequently, key components and indicators of neighborhood resilience were identified through site surveys and the analysis of existing data and documents. Thereafter, earthquake resilience was evaluated by employing the weights associated with physical and social factors. The case study in the Jalaliyeh neighborhood demonstrated the applicability of the approach, and the results showed that resilience varied from west to east. According to the assessment, the neighborhood's social resilience against a possible earthquake is 'low'; while the physical resilience level is 'medium'. Then, employing this approach enables the identification and classification of the measures for improving resilience into 'micro,' 'meso,' and 'macro' levels, allowing the implementation at various levels within the neighborhood.

According to the resilience assessment of Jalaliyeh neighborhood, 34% of the neighborhood area has very high resilience and 10% has high resilience. However, 16% is evaluated with moderate resilience, 24% low resilience and 16% very low resilience. In total, the resilience level of the whole neighborhood is average with amount of 51%. It seems that Jalaliyeh neighborhood has a more suitable level of resilience compared to its adjacent neighborhood, Fatemi neighborhood, against a possible earthquake. The social resilience of Jalaliyeh neighborhood is 30% and its level against earthquakes is low. Based on the indicators of social resilience, the indicators of 'regularity' with a rate of 30%, 'participation' with a rate of 41% and 'communication' with a rate of 50% are critical. However, the 'security' index is at the most

favorable level with 90%.

Existence of large and unplanned population due to multiple medical, educational, administrative and commercial uses with over-regional scale, loss of identity and sense of place, weakening of neighborhood relations, loss of local communities, disappearance of the vitality and ignoring the social capital are the main reasons for the low level of social resilience in Jalaliyeh neighborhood. The proposed interventions to improve the resilience of the neighborhood against earthquakes are renovation and improvement of worn-out urban fabrics, aggregation of blocks and fine-grain parcels, widening of high-enclosed passages, strengthening and improvement of car access, relocation of a number of uses with a lot of visitors, and creating open and green spaces.

The approach proposed in this article is applicable in seismic-prone urban fabrics; however, its parameters should be revised based on the characteristics and local conditions. The flexible structure and features of these steps allow it to be implemented at various levels and scales in different settings. In addition, city planners and disaster management authorities can utilize this approach to evaluate the effectiveness of different interventions for improving neighborhood resilience and to determine the necessary budget, to make the most appropriate decisions for interventions at the neighborhood on the basis of cost-benefit analysis.

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References

- Amini Hosseini, K., Hosseini, M., Izadkhah, Y. O., Mansouri, B., & Shaw, T. (2014). Main challenges on community-based approaches in earthquake risk reduction: Case study of Tehran, Iran. *International Journal of Disaster Risk Reduction*, 8, 114-124. <https://doi.org/10.1016/j.ijdr.2014.03.001>

- Aslani, F., & Amini Hosseini, K. (2024, May 8). Evaluating neighborhood social resilience against earthquakes (Case study: Jalaliyeh neighborhood in District 6 of Tehran City) [Paper presentation]. 9th International Conference on Seismology and Earthquake Engineering, Tehran, Iran.
- Badarin, E. (2023). Localizing resilience: Discursive projections, entrapments and domination. *British Journal of Middle Eastern Studies*, 50(3), 515-530. <https://doi.org/10.1080/13530194.2021.1981234>
- Bosher, L., Chmutina, K., & van Niekerk, D. (2021). Stop going around in circles: Towards a reconceptualisation of disaster risk management phases. *Disaster Prevention and Management: An International Journal*, 30(4/5), 525-537. <https://doi.org/10.1108/DPM-03-2021-0071>
- Bottero, M., Datola, G., & De Angelis, E. (2020). A system dynamics model and analytic network process: An integrated approach to investigate urban resilience. *Land*, 9(8), Article 242. <https://doi.org/10.3390/land9080242>
- Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, K., Wallace, W. A., & von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra*, 19(4), 733-752. <https://doi.org/10.1193/1.1623497>
- Burton, C. G. (2012). *The Development of Metrics for Community Resilience to Natural Disasters* [Doctoral Dissertation, University of South Carolina]. Scholar Commons. <https://scholarcommons.sc.edu/etd/1275/>
- Carpenter, S. R., Westley, F., & Turner, M. G. (2005). Surrogates for resilience of social-ecological systems. *Ecosystems*, 8(8), 941-944. <https://doi.org/10.1007/s10021-005-0170-y>
- Chavoshy, A., Amini Hosseini, K., & Hosseini, M. (2018). Resiliency cube: A new approach for parametric analysis of earthquake resiliency in urban road networks. *International Journal of Disaster Resilience in the Built Environment*, 9(4-5), 317-332. <https://doi.org/10.1108/IJDRBE-11-2017-0065>
- Coulton, C. J., Jennings, M. Z., & Chan, T. (2013). How big is my neighborhood? Individual and contextual effects on perceptions of neighborhood scale. *American Journal of Community Psychology*, 51(1-2), 140-150. <https://doi.org/10.1007/s10464-012-9550-6>
- Doyle, E. E. H., Becker, J. S., Neely, D. P., Johnston, D. M., & Pepperell, B. (2015). Knowledge transfer between communities, practitioners, and researchers: A case study for community resilience in Wellington, New Zealand. *Australasian Journal of Disaster and Trauma Studies*, 19(2), 55-66. https://trauma.massey.ac.nz/issues/2015-2/AJDTs_19_2_Doyle.pdf
- Fekete, A., Hufschmidt, G., & Kruse, S. (2014). Benefits and challenges of resilience and vulnerability for disaster risk management. *International Journal of Disaster Risk Science*, 5(1), 3-20. <https://doi.org/10.1007/s13753-014-0008-3>
- Folke, C. (2016). Resilience. *Ecology and Society*, 21(4), Article 44. <https://doi.org/10.5751/ES-09088-210444>
- Google Earth. (2024). *Google Earth*. <https://www.google.com/earth/about/>
- Holling, C. S., & Gunderson, L. H. (2002). *Resilience and adaptive cycles*. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems*, 25-62, Island Press.
- Japan International Cooperation Agency, Pacific Consultants International, & OYO Corporation. (2000). *The study on seismic microzoning of the Greater Tehran Area in the Islamic Republic of Iran: Final Report, main Report*. https://openjicareport.jica.go.jp/pdf/11611761_01.pdf
- Karakoc, D. B., Almoghathawi, Y., Barker, K., González, A. D., & Mohebbi, S. (2019). Community resilience-driven restoration model for interdependent infrastructure networks. *International Journal of Disaster Risk Reduction*, 38, Article 101228. <https://doi.org/10.1016/j.ijdr.2019.101228>
- Khazai, B., Bendimerad, F., Cardona, O. D., Carreño, M.-L., Barbat, A. H., & Burton, C. G. (2015). A guide to measuring urban risk resilience: Principles, tools

- and practice of urban indicators (1st ed.). *Earthquakes and Megacities Initiative*. https://www.cedim.kit.edu/download/Guidebook_URR_ME-July-2015.pdf
- Kwok, A. H., Paton, D., Becker, J., Hudson-Doyle, E. E., & Johnston, D. (2018). A bottom-up approach to developing a neighbourhood-based resilience measurement framework. *Disaster Prevention and Management: An International Journal*, 27(2), 255-270. <https://doi.org/10.1108/DPM-07-2017-0169>
- Lee, D. W. (2020). An exploratory assessment of infrastructure resilience to disasters. *International Journal of Disaster Resilience in the Built Environment*, 11(4), 519-533. <https://doi.org/10.1108/IJDRBE-02-2019-0006>
- Mayunga, J. S. (2009). Measuring the measure: A multi-dimensional scale model to measure community disaster resilience in the U.S. Gulf Coast region [Doctoral dissertation, Texas A&M University]. *Texas A&M University Repository*. <https://hdl.handle.net/1969.1/ETD-TAMU-2009-05-769>
- Meerow, S., & Newell, J. P. (2019). Urban resilience for whom, what, when, where, and why? *Urban Geography*, 40(3), 309-329. <https://doi.org/10.1080/02723638.2016.1206395>
- Nguyen, H. L., & Akerkar, R. (2020). Modelling, measuring, and visualising community resilience: A systematic review. *Sustainability*, 12(19), Article 7896. <https://doi.org/10.3390/su12197896>
- Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41(1-2), 127-150. <https://doi.org/10.1007/s10464-007-9156-6>
- Pearson, L., & Pelling, M. (2015). The UN Sendai Framework for Disaster Risk Reduction 2015-2030: Negotiation process and prospects for science and practice. *Journal of Extreme Events*, 2(1), Article 1571001. <https://doi.org/10.1142/S2345737615710013>
- Peek, L., Tobin, J., Adams, R. M., Wu, H., & Mathews, M. C. (2020). *A Framework for Convergence Research in the Hazards and Disaster field: The Natural Hazards Engineering Research Infrastructure CONVERGE facility*. *Frontiers in Built Environment*, 6, Article 110. <https://doi.org/10.3389/fbuil.2020.0011>
- Pfefferbaum, R. L., Pfefferbaum, B., Van Horn, R. L., Klomp, R. W., Norris, F. H., & Reissman, D. B. (2013). The Communities Advancing Resilience Toolkit (CART): An intervention to build community resilience to disasters. *Journal of Public Health Management and Practice*, 19(3), 250-258. <https://doi.org/10.1097/PHH.0b013e318268aed8>
- Renschler, C. S. (2013). The PEOPLES resilience framework: An integrated quantitative measure and modeling of sustainable development and disaster risk reduction. United Nations Office for Disaster Risk Reduction. <https://www.undrr.org/publication/peoples-resilience-framework-integrated-quantitative-measure-and-modeling-sustainable>
- Ribeiro, P. J. G., & Gonçalves, L. A. P. J. (2019). Urban resilience: A conceptual framework. *Sustainable Cities and Society*, 50, Article 101625. <https://doi.org/10.1016/j.scs.2019.101625>
- Saja, A. M. A., Teo, M., Goonetilleke, A., Ziyath, A. M., & Gunatilake, J. (2020). Selection of surrogates to assess social resilience in disaster management using multi-criteria decision analysis. *International Journal of Disaster Resilience in the Built Environment*, 11(4), 453-480. <https://doi.org/10.1108/IJDRBE-07-2019-0045>
- Sharifi, A., & Murayama, A. (2013). A critical review of seven selected neighborhood sustainability assessment tools. *Environmental Impact Assessment Review*, 38, 73-87. <https://doi.org/10.1016/j.eiar.2012.06.006>

