Social Vulnerability Guidelines

Technical Report

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Abstract

This report presents a proposal for a Comprehensive Vulnerability Survey (CVS) associated with socio-natural disasters, focused on the characteristics that condition the social vulnerability of occupants of a building, related to physical characteristics of the building that determine its structural vulnerability to the hurricane winds and flood hazards.

A set of 16 questions on socioeconomic parameters and ten questions on the physical parameters of a dwelling are designed and presented so that an individual can assess his family group and the home where they reside. Results can be processed to determine a vulnerability index or category. This report proposes a simplified procedure to obtain a category of social vulnerability from the answers obtained from the 16 questions, resulting in one of the five categories of social vulnerability: 1) Very Low, 2) Relatively Low, 3) Relatively Moderate, 4) Relatively High, and 5) Very High, similar to the categories used by FEMA-NRI. Results can be combined to obtain a Comprehensive Risk Category (or Index)

Content

1. Purpose, Scope, and Conceptualization

The objective is to capture basic information on the social vulnerability of a family group and to capture data on the physical vulnerability of a dwelling subject to the action of socio-natural hazards such as hurricanes and floods. The captured information generates a global vulnerability index that can be applied to a family group and to the home where they reside.

With this intention, a set of 16-questions in socioeconomic parameters is presented, inspired by the information SoVI used from the National Risk Index (NRI) (FEMA, 2020-a). Another 10-question set is defined for the physical parameters of housing, inspired by the HAZUS-FEMA methodology to calculate the risk (FEMA, 2009-c and 2009-d). The results of the social and physical vulnerabilities can be combined for a global vulnerability index.

2. Social Vulnerability Survey

2.1. References and selection of social variables

For this study, the following publications regarding social vulnerability indices developed in the USA have been considered:

- Social Vulnerability Index (SoVI) developed by the University of South Carolina, Hazards and Vulnerability Research Institute, published in Cutter *et al.* (2003), used in its most recent version by FEMA-NRI (FEMA, 2020-a).

- Social Vulnerability Index (SVI) developed by The Centers for Disease Control and Prevention (CDC), published in Flanagan *et al*., 2011; Flanagan *et al*., 2018, used by The U.S. Army Corps of Engineers (USACE).

- Other studies, such as the one by the Institute for Water Resources (IWR) of the USACE that show a comparison of the tools available for social vulnerability analysis (Dunning and Durden, 2013) and another more recent by Colburn *et al.* (2017).

According to Hazards and the Vulnerability Research Institute of the University of South Carolina, social vulnerability represents those social, economic, demographic, and housing characteristics that influence a community's ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards (Cutter *et al.,* 2003).

According to Cutter et al. (2003), "there is a consensus within the social science community about some of the major factors that influence social vulnerability. These include lack of access to resources (including information, knowledge, and technology); limited access to political power and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines (Cutter, 2001a; Tierney, Lindell, and Perry, 2001; Putnam, 2000; Blaikie et al., 1994). Disagreements arise in selecting specific variables to represent these broader concepts".

On the one hand, the Social Vulnerability Index (SVI) developed by the CDC and published by Flanagan et al. (2011) and Flanagan et al. (2018) defines four variables and 15 themes in a percentile index to create a vulnerability index at a census tract level:

- Socioeconomic Status (4 themes): Below Poverty, Unemployed, Income, No High School Diploma.

- Household Composition and Disability (4 themes): Aged 65 or Older, Aged 17 or Younger, Civilian with a Disability, Single-Parent Households.

- Minority Status and Language (2 themes): Minority, Speaks English "less than well."

- Housing and Transportation (5 themes): Multi-Unit Structures, Mobile Homes, Crowding, No Vehicle, Group Quarters.

On the other hand, the Social Vulnerability Index (SoVI) of Cutter *et al.* (2003) of the group of the University of South Carolina, which is the most implemented, presents the following variables as main indicators of social vulnerability:

- Socioeconomic Status (Income, Political Power, Prestige): Socioeconomic status affects the ability of a community to absorb losses and cope with hazard impacts. Wealth enables communities to better prepare for disasters through mitigation and absorb and recover from losses more quickly using insurance, social safety nets, and entitlement programs. Low-status communities have little ability to absorb losses due to poverty populations.

- Gender: Women often have a more difficult time during recovery than men because of sector-specific employment (e.g., personal services), lower wages, and family care responsibilities.

- Race and Ethnicity: These factors impose language and cultural barriers and affect access to post-disaster funding and occupation of high-hazard areas.

- Age: Extremes of age affect movement out of harm's way and require outside supervision and care. Parents lose time and money caring for children when daycare facilities are affected; the elderly may have mobility constraints or medical and cognitive concerns increasing the burden of care before, during, and after the emergency.

- Employment Loss: The potential loss of employment following a disaster increases the number of unemployed workers in a community. Such losses compound the hazard's impact and lead to a slower recovery from the disaster. At an individual level, employment loss equates to a lower ability to pay for necessary goods and services, effectively lowering the ability to prepare and recover from disasters.

- Residential Property: Home value is an indicator of financial capacity. The value and quality of residential construction affect potential losses and recovery. Expensive homes are costly to replace, and mobile homes are easily destroyed by water and winds. The viability of neighborhoods based on the number of unoccupied housing units also contributes to slower long-term recovery.

- Renters: People rent because they are transients, do not have the financial resources for home ownership, or do not want the responsibility of home ownership. They often lack access to information about financial aid during recovery and are not covered by current federal disaster recovery programs. In extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or too costly to afford.

- Occupation: Some occupations, especially those characterized as primary extractive industries, may be severely affected by a hazard event. Primary sector jobs are impacted first during major disasters. For example, self-employed fishermen suffer when their means of production are lost (boats), and they may not have the requisite capital to resume work in a timely fashion; therefore, they may seek alternative employment. The same is true of migrant workers engaged in agriculture. Low-skilled service jobs (housekeeping, childcare, and gardening) may suffer similarly as disposable income fades.

- Family Structure: Families with large numbers of dependents and/or single-parent households often have limited resources to outsource care for dependents and thus must juggle work responsibilities with care for family members. All these factors affect coping with and recovering from hazards.

- Education: Education is linked to socioeconomic status in that higher educational attainment affects lifetime earnings, and limited education constrains the ability to understand warning information and access recovery information.

- Medical Services and Access: Healthcare providers, including physicians and hospitals, are essential post-event sources of relief. The lack of proximate medical services lengthens the time needed to obtain short-term relief and achieve longer-term recovery from disasters. Nursing homes represent an increase in socially vulnerable people, as the resident populations are less able to cope with disasters independently. The availability of health insurance is another factor influencing social vulnerability.

- Social Dependence: People dependent on social services (social security, food assistance) for survival are already economically and socially marginalized and require additional support in the post-disaster period.

- Special-needs Population: Special-needs populations (infirm, institutionalized, transient, homeless) are challenging to identify, let alone measure and monitor. Yet this segment of society is invariably left out of recovery efforts, mainly because of this invisibility in communities.

Table 1 lists the 29 socioeconomic variables considered by the National Risk Index (FEMA, 2020-b), based on the SoVI of Cutter et al. (2003), deemed to contribute to a community's reduced ability to prepare for, respond to, and recover from hazards.

Table 1. List of 29 socioeconomic variables for assessing social vulnerability index (SoVI) (FEMA, 2020-b).

No.	SoVI Variables (FEMA NRI)	Group
1	Average number of people per household	Population
2	Median age	
3	% population under 5 years or age 65 and over	
4	% female	
5	% children living in married couple families	
6	% families with female-headed households with no spouse present	
7	% population speaking English as second language (with limited English proficiency)	Race
8	% Asian population	
9	% African American (Black) population	
10	% Hispanic population	
11	% Native American population	
12	% population over 25 with <12 years of education	Education
13	% civilian labor force unemployed	Employment
14	% female participation in the labor force	
15	% employment in service occupations	
16	% employment in extractive industries (e.g., farming)	
17	Per capita income	Imcome
18	Median gross rent for renter-occupied housing units	
19	% families earning more than $200,000 income per year	
20	% persons living in poverty	
21	% households receiving Social Security benefits	
22	Median dollar value of owner-occupied housing units	Homes
23	% renter-occupied housing units	
24	% population living in mobile homes	
25	% population living in nursing facilities	
26	% housing units with no car available	
27	% unoccupied housing units	
28	% population without health insurance (County SoVI only)	Health
29	Community hospitals per capita (County SoVI only)	

2.2. Questions

In this study, 16 questions have been formulated mainly from the 29 variables of the Social Vulnerability Index (SoVI) by Cutter et al. (2003) used by FEMA in the NRI (Table 1). Some variables are similar to the Vulnerability Index (SVI), from which the criterion of 17-year-old has been taken to define the age of dependent children and adolescents instead of the 5-year-old considered in the SoVI of Cutter. The questions and answers of the 2020 census questionnaire have also been considered (U.S. Census Bureau, 2020), especially that associated with race. The purpose is to capture basic information on a family's social vulnerability. The 16 questions are:

1. **Household occupants**

   Number of People.

2. **Children or adolescents under 17 years old (years old ≤ 17)**

   Number concerning the total members in the family.

3. **People 17 and 65 years old (17<years old>65)**

   Number concerning the total members in the family.

4. **Adults over 65 years old (years old≥65)**

   Number concerning the total members in the family.

5. **Number of women**

   Respect to the total members of the family.

6. **Number of women have a paid job**

   Respect to the total number of women in the family.

7. **People have less than 12 years of study**

   Number concerning the total members in the family.

8. **Headed of household**

   Among the options: Both parents / Only female / Only male.

9. **Predominant race**

   Among the options taken from U.S. Census Bureau (2020): White / Black or African / American Indian or Alaska Native / Hispanic, Latino, or Spanish origin / Asian.

10. **Predominant type of employment**

    Among the options: Unemployed / Employment in service occupations / Employment in extractive industries (e.g., farming) / Non-professional employee in commercial, industrial, or government activities / Professional employee or Own business.

11. **Annual economic income ($)**

    Among the options: Under 15,000 / between 15,000 to 49,999 / between 50,000 to 99,999 / between 100,000 to 199,999 / 200,000 and over.

12. **Social security benefit**

    Among the options: Yes / No.

13. **Type and ownership of the dwelling**

    Among the options: Own home / Rented housing / Own mobile home / Rented mobile home.

14. **Economic value ($) of the home or apartment**

    Among the options: Under 49,999 / between 50,000 to 199,999 / 200,000 and over.

15. **Number of vehicles available in your home**

    Among the options: None / Some adults do not have / One (or more) for each adult.

16. **Health insurance**

    Among the options: Yes, all / Some / None.

2.3. Qualification and Processing of the results

To process the results, the responses that condition greater social vulnerability are quantified with 100, moderate social vulnerability with 50, and low social vulnerability with 0. This allows totalizing all the responses with an additive model where all the variables have the same weight, such as the one used by the SoVI (Cutter et al. 2003), not making any a priori assumption about the importance of each factor in the overall sum. As stated by Cutter et al. (2003), they felt this was a secure option in the absence of a defensible method for assigning weights.

A proposal to qualify the results is shown in Table 2.

Table 2. Qualification of results of the Social Vulnerability Survey.

% of children under 17 years old, % adults over 65 years old, % women in the family % people have less than 12 years of study (% concerning the total members in the family)	Assigned value
≥ 87.51%	100
62.51% − 87.50%	75
37.51% − 62.50%	50
12.51% − 37.50%	25
≤ 12.50%	0

% People between 17 and 65 years (% concerning the total members in the family) % women participate in the labor force (% concerning the total women in the family)	Assigned value
≥ 87.51%	0
62.51% − 87.50%	25
37.51% − 62.50%	50
12.51% − 37.50%	75
≤ 12.50%	100

Headed of household	Assigned value
Only female	100
Only male	50

Both parent	0

Predominant race in the family	Assigned value
Black or African	100
American Indian or Alaska Native Hispanic, Latino, or Spanish origin Asian	50
White	0

Family's predominant type of employment or source of income	Assigned value
Unemployed	100
Employment in service occupations Employment in extractive industries (e.g., farming) A non-professional employee in commercial, industrial, or government activities	50
Professional employee Own business	0

Annual economic income ($)	Assigned value
Under 15,000	100
15,000 to 49,999	75
50,000 to 99,999	50
100,000 to 199,999	25
200,000 and over	0

Receive a social security benefit	Assigned value
Yes	100

None	0

Type and ownership of the dwelling	Assigned value
Rented mobile home	100
Rented housing Own mobile home	50
Own home	0

The economic value of the home or apartment ($)	Assigned value
Under 49,999	100
50,000 to 199,999	50
200,000 and over	0

Number of vehicles available in your home	Assigned value
None	100
Some adults do not have	50
One (or more) for each adult	0

Family members have health insurance.	Assigned value
None	100
Some	50
Yes, all	0

The 16 responses can be normalized to values between 0 and 100 by dividing by 15, since the first question is only used in processing. The result can be interpreted in the same five categories of social vulnerability that the FEMA NRI uses for comparative purposes (FEMA 2020-a, FEMA 2020-b). See Table 3.

Table 3. Social vulnerability categories and Score.

Social Vulnerability Categories (Adapted from FEMA NRI)	Score
Very High	≥ 87.51
Relatively High	62.51 – 87.50
Relatively Moderate	37.51 – 62.50
Relatively Low	12.51 – 37.50
Very Low	≤ 12.50

2.4. Application example

To assess the social vulnerability two hypothetical families are defined with the following characteristics:

- **Example Family 1:** made up of 7 African-American members, of which 4 are children under 15 years of age, 2 are adults over 65 years of age who are the parents of an adult woman, single mother and head of household who works in service occupation and had no more than 12 years of study. They have very low economic income and live in a rented low-cost housing. They receive social benefits and have no vehicles or health insurance.

- **Example Family 2:** made up of 5 members, of which 3 are children or adolescents aged 3, 8 and 15 and the adult couple both work professionally, both head of the family with more than 12 years of study and the 15 years old child. They have a relatively good income that allowed owning a home in a good area of the city. Both parents have vehicles and everyone in the family has health insurance.

Table 4 shows the responses of each family to the 16 questions. The result indicates that family example 1 is relatively highly vulnerable and family example 2 is relatively low vulnerable.

Table 4. Example of application and processing of the social vulnerability survey.

Question	Example Family 1		Example Family 2	
	Answer	Value	Answer	Value
1) How many people live in your household?	7	-	5	-
2) How many children under 17 years old live in your household?	4 (57%)	50	3 (60%)	50
3) How many people between 17 and 65 years old live in your household?	1 (14%)	75	2 (40%)	50

4) How many adults over 65 years old live in your household?	2 (29%)	25	0 (0%)	0
5) How many women live in your household?	5 (71%)	75	2 (40%)	50
6) How many women have a paid job?	1 (20%)	75	1 (50%)	50
7) How many people in the family have less than 12 years of study?	7 (100%)	100	2 (40%)	50
8) Headed of household?	Only female	100	Both parent	0
9) What would be the predominant race in the family?	Black or African	100	White	0
10) What is the family's predominant type of employment or source of income?	Employment in service occupations	50	Professional employee	0
11) Household's annual economic income ($)?	Under 15,000	100	100,000 to 199,999	25
12) Receive a social security benefit?	Yes	100	No	0
13) Type and ownership of the dwelling?	Rented housing	50	Own home	0
14) Estimated economic value ($) of the home or apartment?	Under 49,999	100	200,000 and over	0
15) Number of vehicles available in your home?	None	100	One (or more) for each adult	0
16) Do your family members have health insurance?	None	100	Yes, all	0
Total value		1200		275
Score		80,0		18,3
Social Vulnerability Category	**Relatively High**		**Relatively Low**	

3. Physical Vulnerability of the dwelling

3.1. Physical variables and general indications

A total of 10 questions have been selected with the characteristics of use, age, location, and physical aspects of the building, such as the number of floors, building type, and others related to roofs, windows, and foundations; they condition its vulnerability to hurricane winds or floods. The selected characteristics are the ones that have the most influence on the damage functions that characterize vulnerability in the FEMA-HAZUS methodology.

3.2. Selected questions

The 10 questions are the following:

1. **Location**

   The user should indicate the address of the dwelling.

2. **Occupancy type**

   As shown in the spreadsheet the user should select one between the 11 possible answers: Single Family Dwelling, Mobile Home, Duplex, Triplex/Quads, Multi-Dewlings (5 to 9 units, 10 to 19 units or 20 to 49 units, 50+ units), Temporary Lodging, Institutional Dormitory or Nursing Home.

3. **Built Year**

   The user should give its best estimation of the construction year of the dwelling.

4. **Number of Floors**

   The number of floors is the number of stories above ground level.

5. **Building Type**

   The user should select one between the five types shown in Figures 1 and 2, which are Wood, Masonry, Concrete, Steel or Manufacture (Mobile).

| Wood | Masonry | Concrete |

Figure 1. Building types: Wood, Masonry and Concrete.

Steel	**Mobile or manufactured**	**Manufactured**

Figure 2. Building types: Steel, Mobile and Manufactured.

6. **Roof Deck Age**

   The user should select between these two options regarding the age of the roof deck: New (or average) or Old.

7. **Shutters**

   The user should indicate if there are shutters in the windows.

8. **Basements**

   The user should indicate if there are or there are not basements. See Figure 3.
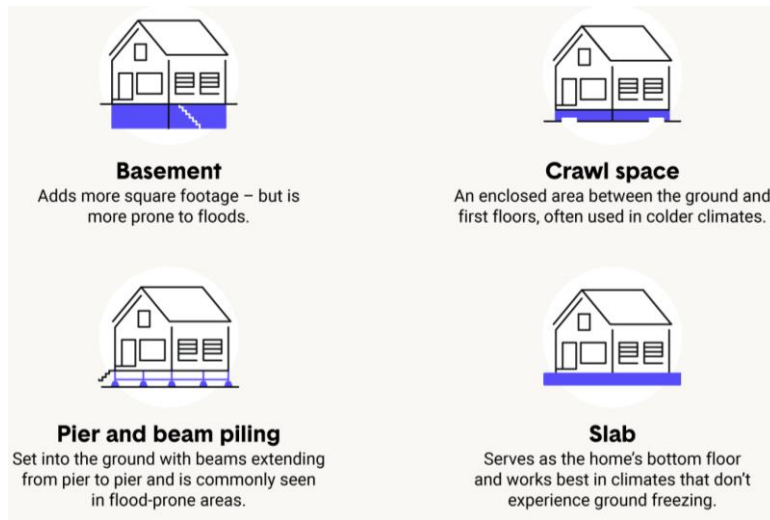
9. **Foundation Type**

   The user should select the foundation type between these eight options: Pile, Pier, Solid, Wall, Basement, Crawl, Fill, or Slab. For some examples, see Figure 4.
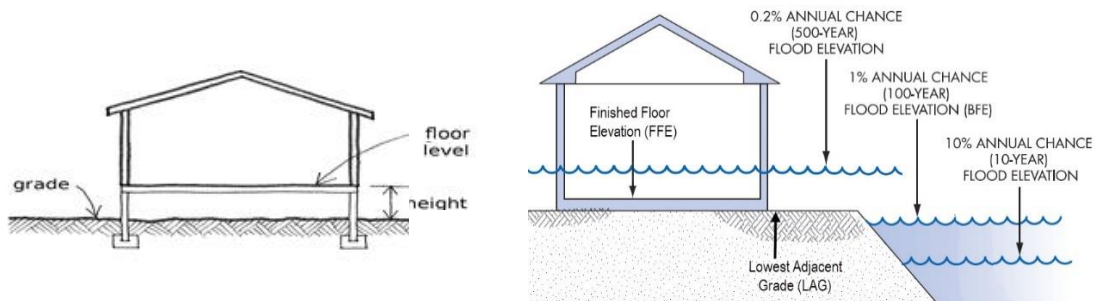
10. **First Floor Height**

    It is the distance between the structure's first floor and the ground level. Also, the level of the first floor habitational floor. It should be given in ft. See Figure 5.

Figure 3. Example of a basement and a crawl space (FEMA, 2018).


Figure 4. Examples of foundation types.

Figure 5. First Floor Height **(see** https://alabasterlandsurveying.com/elevation-certificate.

3.3. Results processing proposal

The proposal is to use a selection of the physical vulnerability curves (damage curves) of the FEMA-HAZUS methodology to estimate losses due to floods and hurricane winds based on the results of the survey and the geographic location of the building, which can be related to available wind and flood hazard maps, which can be done later in the office.

An alternative for the future would be to promote the development of web or mobile applications that allow calculations to be carried out automatically. Two examples of web or mobile applications for estimating losses due to earthquakes are the Temblor Inc App, developed in the USA and the Yanapay App developed in Peru, shown in Figure 8.

<div align="center">

a) Temblor App

https://temblor.net/

b) Yanapay App

https://yanapay.net/

</div>
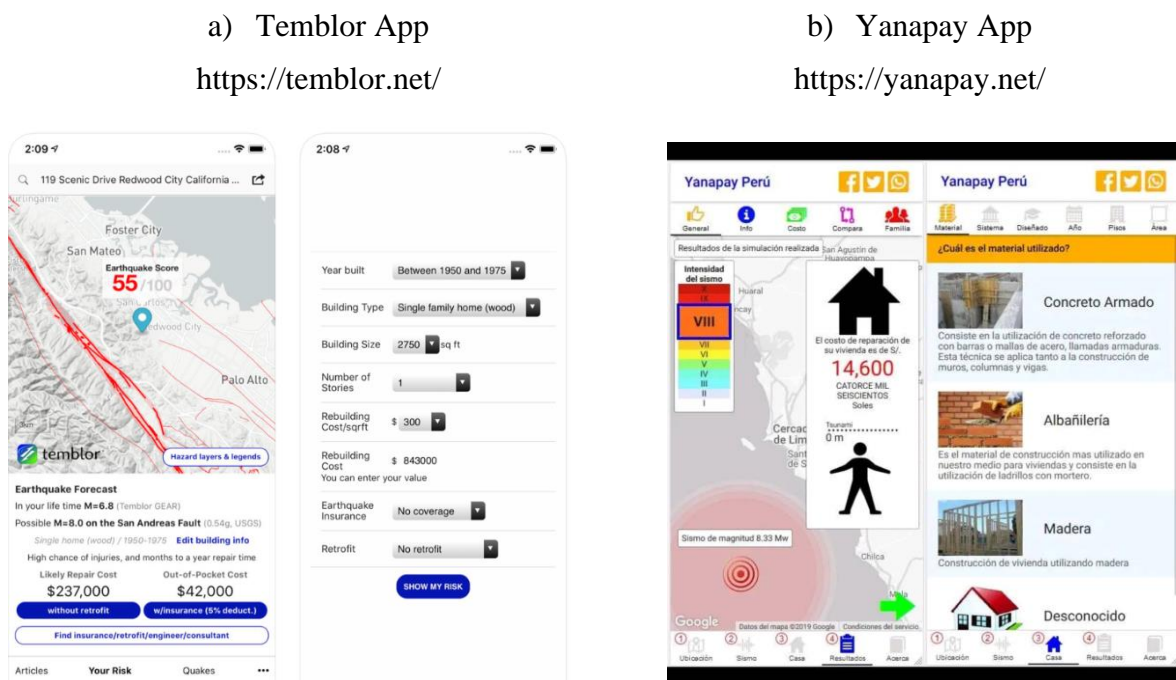
Figure 8. Two examples of web or mobile applications for the estimation of losses based on a physical survey

Finally, the results of the social and physical surveys could be integrated to obtain comprehensive risk indicators.

4. References

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