

# Assessing the Vulnerability to Environmental Hazards – A HERO protocol

## Step 1: Identify and map the natural hazards of a place

1. List the hazards that have occurred in your region. The list should include, but not necessarily be limited to:

- Earthquakes
- Tsunamis
- Volcanoes
- Drought
- Flood
- Fog
- Hail
- Hurricane & Tropical Storm
- Lightning
- Tornado
- Wild/Forest Fire
- Heavy Precipitation
- Snow & Ice
- Temperature Extremes
- Thunderstorms & High Winds

2. For each hazard, find data on:

- Area affected (spatially referenced)
- Frequency
- Magnitude

3. Divide all frequencies equally into 5 categories, and assign each of the hazards a frequency score (F) from 1 (low) to 5 (high). Similarly Divide all magnitudes into 5 equal-interval categories, and assign each of the hazards a magnitude score (M) from 1 (low) to 5 (high).

4. Calculate the weight (w) for each of the hazards:

$$w = F \times M$$

5. Map the area affected for each of the hazards.

6. Overlay the hazard maps, adding the weights derived from (4) for overlapping areas, to create a multi-hazard maps for the area.

## Step 2: Identify and map the technological hazards of a place

1. Identify sources of technological hazards:
  - Point sources for air pollutant emissions (NET and NTI databases)
  - Point sources for polluting water discharges (PCS and NPOD databases)
  - Sites of land contamination (CERCLA and RCRA sites)
  - Toxic Chemical release sites (TRI database)
  - Major road and other transportation networks (e.g., airports, train stations)
2. Map the locations of these pollution sources .
3. Establish a half-mile buffer distance around the major sources of pollution unless a given technological hazard is so potentially harmful or dominates the technological hazards of a site (e.g., a nuclear power plant) that there is reason to use a different buffer to accommodate that hazard. Map the buffer areas and give each of the buffer areas a weight of 1.
4. Overlay the buffer area maps, adding the weights together for overlapping areas.

## Step 3: Evaluate and map coping ability of the population

1. Identify indicators of coping ability. The indicators should include, but not necessarily be limited to:
  - Total population
  - Total housing units
  - Number of females
  - Number of non-white residents
  - Number of people under 18
  - Number of people over 65
  - Number of female-headed single-parent households
  - Number of renter-occupied housing units
  - Median house value
  - Median household income

2. Using the census block group as the mapping unit, calculate the vulnerability index ( $I_n$ ) for each of the block groups. The vulnerability index for each social variable  $i$  is defined as the ratio of the value of that variable in each census block group ( $V_i$ ) to the maximum value ( $V_{max}$ ) for the variable in the county:

$$I_i = \frac{V_i}{V_{max}}$$

All the vulnerability indices should be created in this manner with the exception of median house value and median household income. The vulnerability index for those variables is created in the following way:

$$I_i = 1 - \frac{V_i}{V_{\max}}$$

Standardized in the above ways, the vulnerability indices range from 0 to 1; higher index values indicate higher vulnerability. Because we do not attach specific weights to individual variables, the composite social vulnerability index for each census block group ( $I_n$ ) is defined as the arithmetic mean of the vulnerability indices of all variables.

$$I_n = \frac{\sum I_i}{n}$$

3. Map the vulnerability index

#### **Step 4: Synthesize natural and technological hazards with social coping abilities**

1. Overlay the technological hazard map(s) with the natural hazard map(s), adding the total weights for overlapping areas, to create a total hazard map.
2. Put the social vulnerability index into 5 equal-interval categories, and assign each of the block groups a coping ability score (C) from 1 to 5.
3. Overlay the total hazard map with the coping ability map, multiplying the hazard weights by the coping ability score (C), to obtain a total vulnerability map of the place.