

A working protocol for assessing vulnerability of a place

A case study of Spring Creek watershed,
Pennsylvania

Structure of vulnerability assessment

1. Define the study area
2. Identify major environmental hazards (natural and technological)
3. Map environmental hazards
4. Identify major indicators for social vulnerability
5. Calculate and map social vulnerability indices
6. Overlay hazard map with social vulnerability map to get the total vulnerability

Step 1: Define Study Area

- Determine study area boundaries
 - Include subsurface boundaries for watershed?
 - Restrict boundary to surface water?
 - Include several boundary levels?
 - State
 - County
 - Sub-County

Step 2: Identify Environmental Hazards

- Identify natural hazards
 - Gathering data
 - Listing natural hazards in study area
 - Ranking hazards to determine relative priority
 - Mapping natural hazards across study area
- Identify technological hazards
 - Gathering data
 - Map technological hazards in study area

Gathering Natural Hazards Data

- Access National Climate Data database and others (NOAA, FEMA, etc.)
- Download data (past ~100 years) into statistics program for analysis
- Follow NOAA CSC relative priority matrix for determining natural hazard impacts
 - Frequency + impact area = magnitude
 - Rank hazards

Listing natural hazards for Spring Creek watershed

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

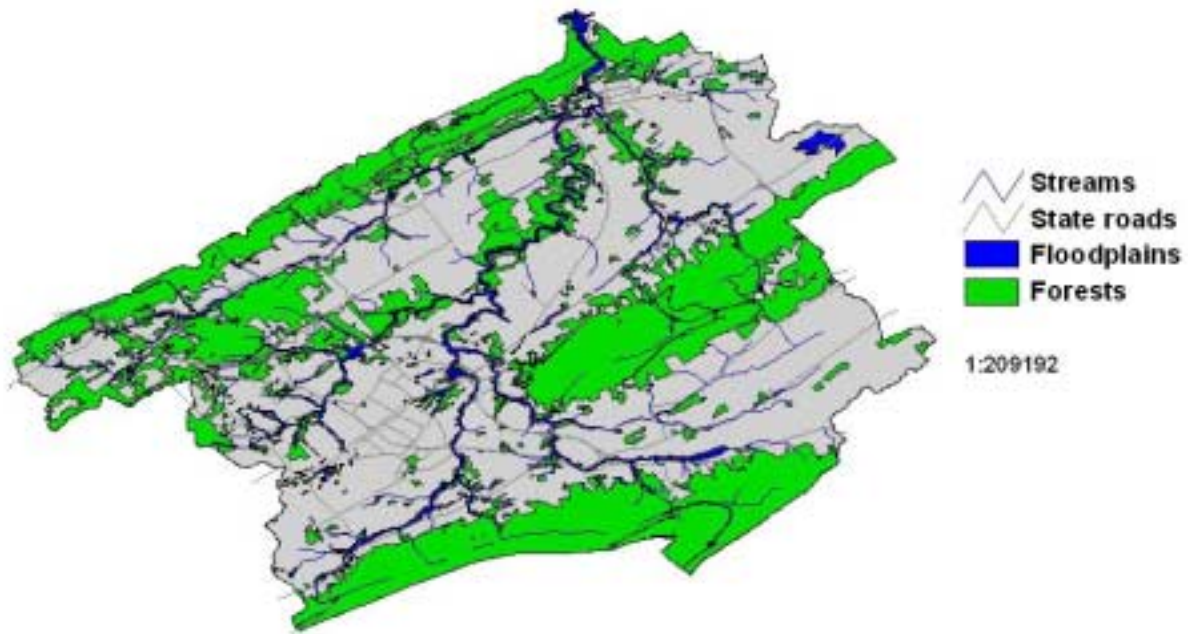
Ranking Natural Hazards using relative priority matrix

Natural Hazard	Frequency	Area of Impact	Magnitude of Damages	Total Risk
Drought	2	5	5	35
Flood	3	4	1	7
Hail	2	1	1	3
Tornado	1	1	1	2
Heavy Rain	1	1	1	2
Snow & Ice	4	5	4	36
Temp. Extremes	1	5	2	12
Thunderstorm & high winds	5	5	3	30

Mapping Natural Hazards

- Gather spatial data representing identified natural hazards
- Add layers of data (floodplains, forested areas, etc.) into GIS
- Include study area boundary and additional smaller boundaries, based on natural hazards classifications

Spring Creek watershed: natural hazards map



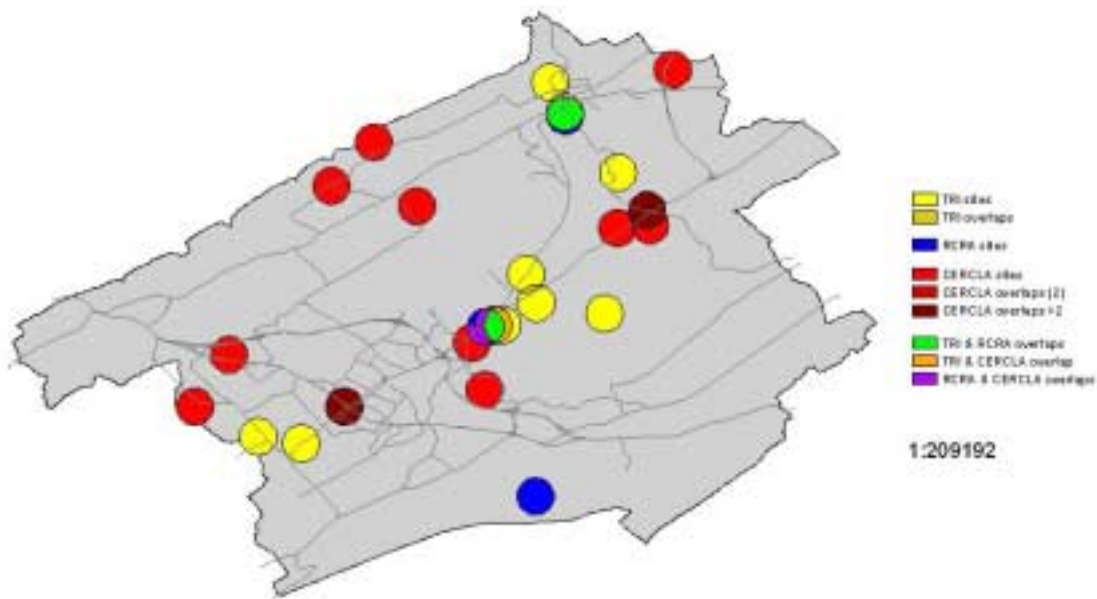
Gathering technological hazards data

- Include transportation networks and major intersections, buffering for potential accidents, spills, and fires
- Access EPA database for toxic chemical sites
- Include current and archived sites
- Record site locations and descriptions for:
 - CERCLA (Superfund)
 - RCRA (Resource Conservation and Recovery Act)
 - TRI (Toxic Release Inventory)
- Buffer chemical site locations

Mapping technological hazards

- In a GIS, assign a value of "1" to each natural hazard, creating a map of hazardous areas
- Create a map of buffered areas around chemical sites and transportation networks
- Assign a value of "1" to each technological hazard and overlay it with natural hazards
- Analyze the results in a GIS, consider applying a weighted scale for some hazards

Spring Creek watershed: technological hazards map



Step 4: Identify indicators of social vulnerability

- Coping ability (resistance and resilience)
 - Technology and infrastructure
 - Settlement description: own, rent
 - Utility networks
 - Critical facilities
 - Social environment
 - Age, gender, ethnicity, household type
 - Economic environment
 - Income, house value, assets, insurance, debts

Step 5: Calculate and map social vulnerability

- For each census unit, normalize variable value with respect to the maximum value within the county

$$I_n = V_n/V_{\max}$$

- Calculate composite index by summing normalized variable values and dividing by the number of variables

Mapping social vulnerability in the Spring Creek watershed

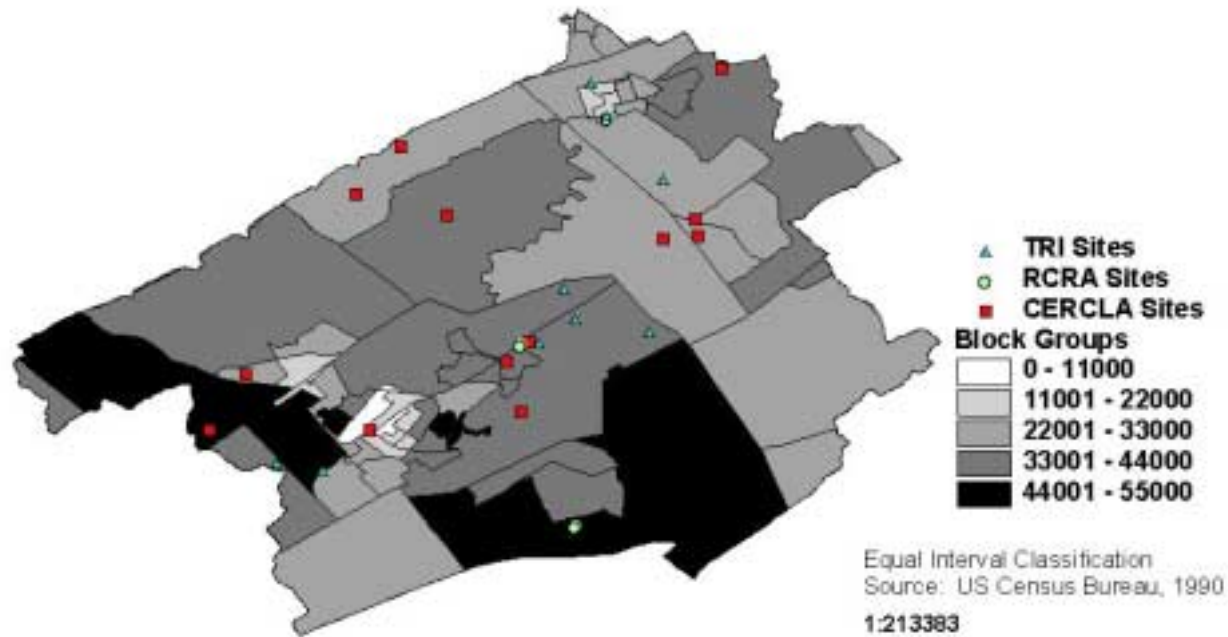


Figure 2: Median Incomes

Step 6: Creating a total vulnerability map

- Overlay environmental hazard maps with vulnerability maps to determine areas vulnerable to environmental hazards
- Add the values for each variable in each layer to represent “total vulnerability”

Incorporating LULCC

- LULCC:
 - Land use: people's perceptions of how land is used
 - Land cover: how land is physically used
- Consider incorporating land use and land cover data into existing research to determine how these changes relate to vulnerability
- Overlay buffers of environmental hazards with land use and land cover maps

Overlaying LU/LC with technological vulnerability in the Spring Creek watershed

