Appendix B

Social Vulnerability Mapping Resource Review

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Methodology Reviews

To develop SVI maps for Resilient Connecticut, several resources have been evaluated to identify the various factors included and the process by which social vulnerability was represented. The resource review includes academic peer-reviewed journals along with government related resources. Factors used for each of the subsequent sources can be found in table 1.

University of South Carolina

The University of South Carolina has developed one of the more often-cited SVI tools available. The Social Vulnerability Index (SoVI®) 2010-14 measures the social vulnerability of U.S. counties to environmental hazards. The index is a comparative metric that facilitates the examination of the differences in social vulnerability among counties. SoVI® is a valuable tool for policy makers and practitioners because it graphically illustrates the geographic variation in social vulnerability. It shows where there is uneven capacity for preparedness and response and where resources might be used most effectively to reduce the pre-existing vulnerability. SoVI® also is useful as an indicator in determining the differential recovery from disasters using empirically based information.

The index synthesizes 29 socioeconomic variables which the research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. SoVI® data sources primarily include those from the United States Census Bureau. SoVI® 2010-14 marks a change in the formulation of the SoVI® metric from earlier versions. New directions in the theory and practice of vulnerability science emphasize the constraints of **family structure, language barriers, vehicle availability, medical disabilities, and healthcare access** in the preparation for and response to disasters, thus necessitating the inclusion of such factors in SoVI®.

This tool (Cutter et al., 2003) identifies three accepted main principles of social vulnerability research:

- Identify the conditions that make people or places vulnerable to extreme natural events

- The assumption that vulnerability is a social condition, a measure of societal resistance or resilience to hazards
- Integration of potential exposures and societal resilience with specific focus on particular places or regions.

Social vulnerability is typically challenging to identify as it is not easily quantifiable, hence the lack of social loss information in post-storm data. A social vulnerability is thought to be a product of part social inequality and place inequality. Social inequalities are those social factors that may influence a community's susceptibility to harm and drives their capability to respond. Place inequality are the community and built characteristics that contribute to social vulnerability.[1]

There has been notable discussion on the specific factors used to determine social vulnerability, however there is a general consensus on *some* factors that play a role, including:

- Lack of access to resources
- Limited access to political power and representation
- Social capital (including networks and connections)
- Beliefs and customs
- Building stock and age
- Frail and physically limited individuals
- Type and density of infrastructure and lifelines

The Cutter et al. methodology includes the identification of over 250 variables were identified, which were then narrowed to a subset of 85. All variables were then normalized (percentages, per capita, or density), resulting in 42 variables for a statistical analysis. Principal component analysis, a statistical analysis, was used as a reduction method as this analysis allows for temporal monitoring and spatial replication.

Below are some of the overarching themes used in the SoVI and how they may be relevant to the Resilient Connecticut program.

Wealth: recover quickly, however, more material goods at risk – in general, lack of wealth is a primary contributor as this often translates to a lack of resources.

Age: most affected by hazards are elderly and children.

Density of built environment: density of manufacturing/commercial, housing unit, new permits, signifies where significant loss could be expected.

Single-sector dependence: likely not relative to Resilient CT.

Housing stock and tenancy: mobile homes, renters, urban living. Displacement is typically higher in urban, while mobile home destruction is more common in rural.

Race & Ethnicity: African American can also be indicative of high female headed households, which are typically the most vulnerable. Also, Asian, Hispanic, and Native American.

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[1] Cutter

Social Capital

As discussed by Kyne and Aldrich (2020), social capital captures the ties which bind people together and serves as the "primary base for a community response".[2] In order to build community resilience and increase proactive climate change planning, social capital factors should be taken into consideration as these characteristics can often determine a community's response and recovery after an event. For example, whether or not to evacuate or the available support post-disaster depends on the strength of community social capital. Kyne and Aldrich present three social capital categories: bonding, bridging, linking. In addition to the three categories, there are several other ways to measure social capital such as cognitive and behavioral, communitarian and institutional, and networked vs individual[2]. The three categories can be loosely defined as:

- Bonding is individuals building social capital based on similar characteristics and building and maintaining social capital through cohesion. This can also be referred to as homophily, or when groups and contacts share languages, culture, class, or ethnicity.
- Weaker ties, or bridging social capital, are connections where there is less in common and people who spend less time together. May be important for after a disaster, as these groups may be geographically different – i.e. churches in lower risk areas opening shelters after an event.
- Linking is between regular people and those with power and authority. This is essential for linking those impacted with those that control resources.

Taking these three types of capital into consideration, Kyne and Aldrich developed a Social Capital Index (SoCI). This index incorporated data from each of the three components, bridging, bonding, and linking, and used arithmetic averages to create the sub-index scores and then added them to the final SoCI. Specifically, the SoCI uses the minimum-maximum method, where adjustment is done by subtracting the minimum value and dividing by the range of the indicator values. All indicators are summed and weighted equally.

Federal Social Vulnerability Index

According to the CDC, "social vulnerability" refers to the potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss. CDC's Social Vulnerability Index (CDC SVI) is a tool that uses U.S. Census data to determine the social vulnerability of every census tract. CDC SVI uses 15 U.S. census variables to help local officials identify communities that may need support before, during, or after disasters. ATSDR's Geospatial Research, Analysis & Services Program (GRASP) maintains CDC SVI to help public health officials and local planners better prepare for and respond to emergency events like hurricanes, disease outbreaks, or exposure to dangerous chemicals. The maps developed are available to aid in specific planning efforts such as for building emergency supply caches, identifying areas in need of shelters, developing evacuations plans, and to provide continued support to recovering communities.

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[2] Kyne

The SVI incorporates 15 social factors which are grouped into four themes:

- Socioeconomic status (below poverty, unemployed, income, no high school diploma)
- Household composition & disability (aged 65 or older, aged 17 or younger, older than age 5 with a disability, single-parent households)
- Minority status & language (minority, speak English "less than well")
- Housing type & transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters)

The 15 factors used are based on census tract data and are ranked according to their percentile. Factors are ranked for relative vulnerability in individual states, and ranked tracts for the entire United States against one another. The ranking values range from 0 to 1, with higher value indicating an increased vulnerability. Each factor is individually ranked, which then comprises a final theme rank, with all four themes providing an overall vulnerability position.

Natural Hazard Screening Index

Comprised of 5 major factors, or domains and has been applied to all counties of the US.

1. Natural environment
2. Society
3. Built Environment
4. Governance
5. Risk

Risk was modeled using historic and modeled exposure, likelihood of exposure, potential anthropogenic exposures, and losses. Risk was calculated as the exposure indicators multiplied the loss indicator. For the other four domains: metrics were adjusted as appropriate then standardized, indicator scores (a combination of the metrics) were determined by the average of the standardized metric scores, with the overall domain value being determined from the average standardized indicator value.

Environmental Justice Mapping Tools

EJ mapping tools typically take social vulnerability mapping tools much further by combining them with factors such as locations of power plants and hazardous waste sites, to depict locations of EJ communities. Social vulnerability factors are therefore inherently a component of EJ analysis.

EJScreen

EJSCREEN is an environmental justice mapping and screening tool developed by EPA. The tool provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. EJSCREEN users choose a geographic area. The tool then provides demographic and environmental information for that area. All of the EJSCREEN indicators are publicly available data. EJSCREEN simply provides a way to display this information and includes a method for combining environmental and demographic indicators into EJ indexes. EJSCREEN includes:

- 11 environmental indicators such as particulate matter, ozone, and proximity to hazardous waste sites

- 6 demographic indicators
- 11 EJ indexes such as particulate matter, ozone, and proximity to hazardous waste sites

It is unclear why the environmental indicators and EJ indicators are similar. The six demographic indicators are:

- Percent Low-Income
- Percent Minority
- Less than high school education:
- Linguistic isolation
- Individuals under age 5
- Individuals over age 64

Washington State Environmental Health Disparities Map

This project recognized that many EJ mapping tools have not explicitly integrated community voice and lived experience as an integral part of their development. Communities across Washington State have historically expressed the need for neighborhood-level information on the cumulative impact of environmental hazards and social conditions to illuminate disparities and address environmental justice issues. This tool helps meet this need.

Seven socioeconomic factors were used in the mapping:

- Low educational attainment
- Housing burden
- Linguistic isolation
- Poverty
- Race
- Transportation expense
- Unemployment

These were combined with numerous environmental indicators and aggregated through a methodical process to determine final composite scores that were mapped.