

Social Vulnerability Across U.S. Counties and States: A Thematic Overview

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Abstract

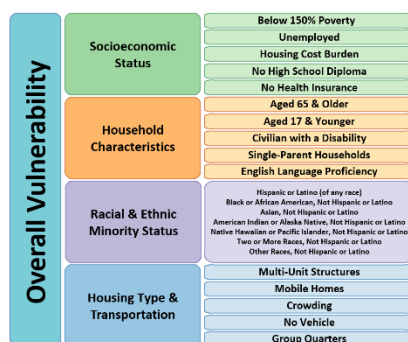
Understanding and addressing social vulnerability at the state level is critical for targeted resource allocation and intervention planning. Social vulnerability reflects a community's capacity to prepare for, respond to, and recover from external stresses on human health, such as natural disasters or disease outbreaks. This project explores the identification of high-vulnerability states based on the Social Vulnerability Index (SVI) and analyzes the contributions of key SVI themes to overall vulnerability scores. The study uses data from government sources to merge, filter, and preprocess datasets containing SVI values and social determinants of health (SDOH) data. The research identifies patterns in SVI scores at a state level, particularly highlighting regional disparities in social vulnerability. Key findings reveal that Southern and Southwestern states exhibit high SVI scores, driven primarily by themes such as poverty, unemployment, and single-parent households. In addition to identifying these high-vulnerability states, the study examines thematic contributions to these scores, offering insights into which areas of vulnerability need targeted interventions, such as housing support or economic assistance. The findings provide a comprehensive view of social vulnerability across the United States by leveraging geospatial mapping and interactive visualizations. These insights lay the foundation for informed policy decisions aimed at mitigating social inequities and improving community resilience. This work highlights the significance of integrating data analytics and visualization in addressing complex social issues and creating actionable frameworks for intervention planning.

Introduction

The origin of the Social Vulnerability Index (SVI) was a response to The Pandemic and All-Hazards Preparedness Act of 2006 citing that public health preparedness and response capabilities were critical needs for the nation. CDC/ATSDR and the Office of Environmental Health Emergency Management (OEHEM) decided to address social vulnerability as it relates to natural or human-caused hazards and public health emergencies. In 2007, a group including social scientists, geographers, and a statistician within the Geospatial Research, Analysis, and Services Program (GRASP) began developing the Social Vulnerability Index. The first CDC/ATSDR SVI database was released in 2011 and the team published the SVI approach and methodology in the paper titled, “[A Social Vulnerability Index for Disaster Management](#)” (Flanagan, B.E., Gregory, E.W., Hallisey, E.J., Heitgerd, J.L., & Lewis, B. (2011)).¹

Since then, the SVI has been and continues to be used to assist public health officials and local planners better prepare for and respond to emergency events to decrease human suffering, economic loss, and health inequities. Currently, social vulnerability is assessed by 16 U.S. Census variables that are grouped into 4 themes and then given an overall single measure social vulnerability score influenced by factors such as economic stability, education, and housing, which plays a crucial role in shaping community resilience.

Figure 1. SVI variables grouped into four themes



Identifying regions with high vulnerability helps allocate resources effectively and address inequities. This project focuses on using datasets and methodologies to evaluate county-level SVI scores and aggregating them to state-level average SVI scores to understand the thematic contributions behind the scores.

Data Description

The dataset used for this study comprises two primary sources: *SVI_USCounty_2020.csv*, which contains county-level SVI scores, and *sdoh_data.csv*, providing data on social determinants of health. These datasets were obtained from reputable sources, including the Centers for Medicare & Medicaid Services (2024) and the Agency for Toxic Substances and Disease Registry (2024). Together, they cover 3,142 rows and 32 columns, with key variables such as the SVI Score, SPL_THEMES (1–4), State, and FIPS codes. The SVI Score ranges from 0 (indicating the lowest vulnerability) to 1 (indicating the highest vulnerability), while the SPL_THEMES categorizes social vulnerability into four areas: socioeconomic status, household composition, housing and transportation, and minority status. The dataset also includes geospatial identifiers such as State and FIPS codes to facilitate regional analysis.

To prepare the data for analysis, preprocessing steps were undertaken. The datasets were merged to create a unified view of SVI and SDOH data, ensuring all necessary variables were combined for comprehensive analysis. Missing values were assessed with none found. Key variables were filtered to focus the analysis on state-level social vulnerability insights. Additionally, the data were standardized to ensure consistency and comparability across states, providing a solid foundation for further exploration and visualization.

Methodology

The methodology used in this study combined data analysis techniques and powerful visualization tools to uncover insights into social vulnerability across states of the continental U.S. Several libraries were utilized, including:

- Matplotlib for static visualizations like bar charts,
- Plotly for creating dynamic and interactive charts,
- Dash for developing interactive dashboards,
- GeoPandas and Geoplot for geospatial mapping, and
- Seaborn for analyzing correlations and trends.

These tools allowed for comprehensive exploration and presentation of the data.

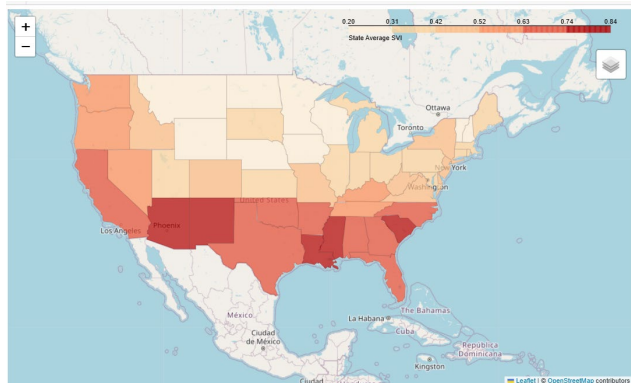
The approach began with exploratory data analysis (EDA) to compute summary statistics for SVI scores and themes and examine their distributions across states. Visualizations were then designed to highlight key insights. Choropleth maps were used to depict geographic disparities, while bar charts provided a comparative analysis of theme-level contributions to state SVI scores. Additionally, dashboards were developed using Dash, incorporating multi-select options to facilitate trend exploration and comparisons across states and themes.

The rationale for selecting these tools and techniques centered on their flexibility and ability to provide both static and interactive visualizations. This ensured that the results were not only detailed but also user-friendly. Geospatial tools were instrumental in uncovering regional patterns and aiding in the understanding of social vulnerability on a state-by-state basis.

Results and Visualizations

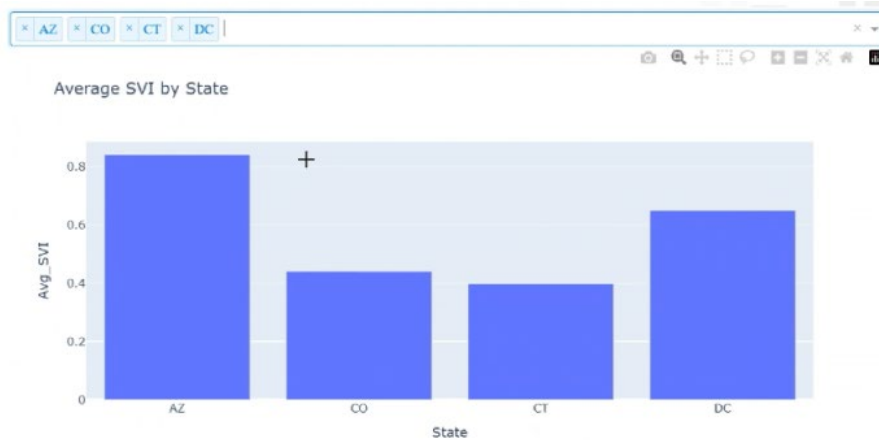
The analysis revealed several key insights into social vulnerability at the state level. Southern and Southwestern states consistently exhibited higher-than-average SVI scores, indicating a greater level of vulnerability in these regions. Theme 1, encompassing economic factors such as poverty, unemployment, and low levels of education, emerged as the most significant contributor to state SVI scores. Additionally, states with high rates of single-parent households, categorized under Theme 2, also displayed elevated vulnerability levels, highlighting the compounded impact of household composition on social resilience. Visualizations played a pivotal role in illustrating these findings. A choropleth map was created to display the average SVI scores by state, effectively emphasizing state/regional disparities. Arizona was found to have the highest SVI score of 0.8419 and North Dakota with lowest SVI score of 0.2023.

Figure 2: Avg_SVI scores by state, Emphasizing Regional Disparities



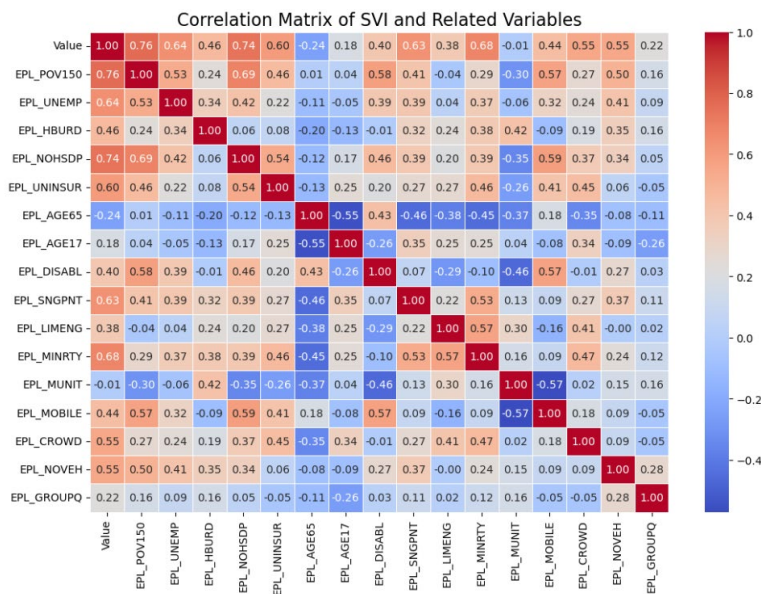
Complementing this, an interactive bar chart showcased the average contributions of each SVI theme to state scores, providing a comparative view of thematic influences across states.

Figure 3: Dash interactive Bar Chart – Avg_SVI comparison by State



Lastly, a correlation matrix was employed to examine the relationships between SVI scores and specific socioeconomic indicators. This visualization highlighted strong correlations between SVI scores and factors such as unemployment rates and poverty levels, further supporting thematic analysis.

Figure 4: Relationships between SVI and Economic Profile Layers



Discussion

The findings of this analysis underscore the critical role that economic and family structure factors play in shaping social vulnerability. Economic factors, such as poverty, unemployment, and low education levels, significantly contribute to high SVI scores, particularly in Southern and Southwestern states. Additionally, household composition—specifically, the prevalence of single-parent households—emerged as a notable factor in certain states/regions. These insights point to the need for targeted interventions, such as employment programs, affordable housing initiatives, and educational support, to mitigate vulnerabilities in high-SVI states and enhance community resilience.

The project was not without challenges. Technical difficulties when re-running code presented significant hurdles. Balancing the demands of this analysis with academic and professional responsibilities further complicated the process. However, these challenges were addressed through incremental debugging and focused preprocessing efforts, which streamlined the data preparation and analysis phases effectively.

Conclusion

This study successfully identified high-vulnerability states and explored the thematic drivers of social vulnerability. Economic factors, such as poverty and unemployment, emerged as the most critical contributors.

Impact

The findings could equip policymakers with actionable insights to target resources and interventions more effectively. The interactive dashboards developed in this project can support ongoing monitoring and decision-making.

Future Work

- **Data Expansion:** Incorporate additional datasets to enrich the analysis.
- **Visualization Tools:** Implement more advanced visualization platforms like Tableau.
- **Policy Simulation:** Develop models to simulate the impact of potential interventions on reducing vulnerability.

References

1. [SVI Values by County](#)
2. [SVI Themes by County](#)
3. [PubMed Article](#)
4. [BMC Public Health Article](#)

GitHub Repository: <https://github.com/BridgettGordon/UnstructlySeen>

¹ <https://www.atsdr.cdc.gov/place-health/php/svi/index.html>