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Development and Diffusion of the Social Capital Index (SoCI)

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Abstract

Social capital influences community disaster preparedness, response, and recovery. In 2020, Kyne and Aldrich introduced the Social Capital Index (SoCI), a pioneering, publicly available county-level measure capturing bonding, bridging, and linking social capital across the United States. Since then, the SoCI has been widely adopted across disciplines and applied in diverse research contexts. Five years later, emerging theoretical developments and expanded data availability offer an opportunity to reassess its diffusion and strengthen its methodological foundations. This study addresses three objectives: (1) revisiting the conceptual roots that informed the original index, (2) examining its diffusion through citation and co-citation analyses of published literature, and (3) updating and extending its measurement framework using 2022 data. The results show that theories of bonding, bridging, and linking social capital shaped the index's design; that the SoCI has diffused across environmental science, public administration, geography, public health, and sociology; and that expanding the index from 19 to 26 indicators enhances its theoretical alignment and empirical coverage. These updates improve the SoCI's ability to complement existing indicators and deepen understanding of relational capacity, vulnerability, and resilience across U.S. counties.

Keywords: Social Capital Index (SoCI); bonding; bridging; linking; community resilience; state-level analysis; publicly available data

1. Introduction

Social capital has become a central concept in understanding how communities mobilize resources, coordinate action, and navigate crises. Long before the term gained widespread traction, scholars recognized that relationships, trust, and civic life shape the social fabric of places and influence collective outcomes (Hanifan 1916; Jacobs 1961; Putnam 1993). In disaster and resilience research specifically, social capital is now widely regarded as a key determinant of how communities prepare for, withstand, and recover from hazards (Aldrich 2012; Norris et al. 2008). Recognizing the need for a systematic, policy-relevant measure of these relational capacities, Kyne and Aldrich (2020) developed the Social Capital Index (SoCI), the first county-level, publicly available composite index designed explicitly to measure bonding, bridging, and linking social capital in the United States.

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The publication of the SoCI represented a significant methodological advance. Drawing on 19 indicators derived from the U.S. Census and related administrative sources, Kyne and Aldrich (2020) introduced a transparent and reproducible framework for quantifying social capital at a scale relevant to emergency management, hazard mitigation, and community resilience. Since its release, the SoCI has been widely adopted by researchers, practitioners, and government agencies. Its diffusion across fields, including environmental science, geography, public administration, public health, and sociology, reflects its growing scientific influence and cross-sectoral utility. This pattern parallels the trajectory of other major composite indices, such as the Social Vulnerability Index (SoVI), which achieved broad recognition through scholarly uptake and subsequent methodological refinement (Cutter et al. 2003).

Now, five years after the SoCI's introduction, there is a compelling need to revisit and reassess both its conceptual foundations and its empirical diffusion. The theoretical landscape of social capital has continued to evolve, offering clearer distinctions among bonding, bridging, and linking relationships and new insights into their contributions to community outcomes (Szreter and Woolcock 2004; Woolcock 1998). At the same time, improvements in publicly available data enable more precise measurement of the demographic, organizational, and institutional components of social capital. The widespread engagement with the SoCI across the academic literature further provides an opportunity to examine how the index has been interpreted, adapted, and applied in diverse research settings.

Building on this motivation, the present study addresses three guiding research questions:

1. What are the conceptual roots of the Social Capital Index (SoCI)?: This question examines the historical, theoretical, and empirical conversations that shaped understandings of social capital and informed the development of the original index.
2. How has the SoCI diffused across scholarly and applied communities since 2020?: To address this question, we analyze how the index has traveled through academic and practitioner circles by tracing its citation patterns, co-citation networks, disciplinary pathways, and global uptake.
3. How can the SoCI be advanced, updated, and methodologically refined?: In pursuing this question, we introduce an expanded SoCI that integrates 2022 data, additional indicators, refined normalization procedures, and an overall strengthened measurement framework.

This study makes three primary contributions. First, it situates the SoCI within the broader conceptual evolution of social capital, clarifying how classical theoretical perspectives and modern multidimensional frameworks converge in its operationalization. Second, it provides the first systematic assessment of the SoCI's scholarly diffusion, offering insight into how a novel composite index becomes embedded within interdisciplinary research communities. Third, it advances the original methodology by developing an updated and more comprehensive SoCI, expanding the indicator set from 19 to 26 variables and enhancing its analytic capacity for resilience, vulnerability, and community studies. Together, these contributions strengthen the empirical foundations of social capital research and support more nuanced assessments of the relational structures that shape local resilience across the United States.

2. Roots of the Social Capital Index (SoCI)

2.1. Conceptual Roots of Social Capital

The evolution of social capital can be understood through four major periods: (1) the pre-term foundations (17th century to early 20th century), when core themes emerged

within classical political economy; (2) the early use of the term (early 20th century to early 1980s), when the concept appeared sporadically with minimal conceptual development; (3) the early conceptual development period (early 1980s to early 1990s), when foundational theorists formalized its meaning; and (4) the period of popular use from the early 1990s to the present, during which the concept expanded rapidly across the social sciences (Claridge 2021).

The pre-term foundations draw from classical social and political thinkers who emphasized the importance of social relationships, civic life, and collective norms long before the term “social capital” was coined. Scholars such as Smith, Marx, Weber, Durkheim, Tocqueville, and Tönnies examined how social ties, solidarity, and associative life shape economic and collective outcomes (Durkheim 1893; Marx et al. 1990; Tocqueville 2019; Tönnies 2017; Weber 2002). Their ideas laid the groundwork for later conceptualizations of community cohesion, trust, and collective action.

During the early use of the term (early 20th century–early 1980s), “social capital” appeared only intermittently. Hanifan (1916) used the term to describe the value of goodwill and cooperation in rural school communities. Jacobs (1961) discussed neighborhood networks and urban vitality, while Seeley et al. (1956), Homans (1974), and Loury (1977) applied the term in their respective contexts. Although dispersed and conceptually inconsistent, these early contributions signaled rising scholarly interest in the value of social relationships.

The early conceptual development period (early 1980s–early 1990s) marked the emergence of systematic theorization. Bourdieu (1986) conceptualized social capital as a resource linked to power and class structures; Coleman (1988, 1994) emphasized the role of obligations, norms, and trust in facilitating collective action; and Putnam et al. (1994) connected civic engagement with institutional performance. These works provided theoretical scaffolding for contemporary social capital research and established the foundations of its multidimensional structure.

The popular use period (early 1990s–present) reflects the rapid expansion of the concept across the social sciences. Putnam’s *Making Democracy Work* (1994) and *Bowling Alone* (2000) were central to this surge, demonstrating how social networks, trust, and civic engagement influence democratic performance and community well-being. As a result, social capital gained widespread adoption in fields such as public health, economics, political science, environmental studies, and community development, becoming a key framework for examining social and institutional outcomes (Coleman 1994; Woolcock 1998).

A defining feature of this popular use period is the widespread adoption of the bonding, bridging, and linking framework. Putnam (2000) popularized the distinction between bonding and bridging social capital, describing bonding ties as inward-looking and reinforcing group cohesion and bridging ties as outward-looking and connecting individuals across diverse groups. Woolcock and Narayan (2000) and Szreter and Woolcock (2004) later introduced the concept of linking social capital to capture vertical relationships between communities and institutions. This multidimensional framework became the dominant structure used across sociology, public health, political science, disaster studies, and community resilience research. Its adoption reflects the recognition that social capital operates across both horizontal and vertical relationships, and it has significantly shaped contemporary empirical measurement, including composite indices such as the Social Capital Index (SoCI).

Alongside network- and institution-focused approaches, an important strand of scholarship emphasizes empathy and sympathy as foundational motivations underlying social relationships. Rooted in Adam Smith’s *Theory of Moral Sentiments*, this perspective highlights moral sentiments, mutual regard, and concern for others as central drivers of cooperative behavior. Building on this tradition, Robison et al. (2000) argue that many

prevailing definitions of social capital conflate the concept itself with its outcomes or correlates, such as economic performance or civic participation. They instead conceptualize social capital as sympathy embedded in social relationships with capital-like properties and demonstrate early efforts to operationalize this concept using U.S. Census-based household income distributions. Acknowledging this line of work situates the Social Capital Index (SoCI) within a broader conceptual and empirical tradition, while underscoring ongoing debates about how social capital should be defined, measured, and distinguished from its effects.

2.2. Foundation of the SoCI

Drawing on these conceptual traditions and debates, Kyne and Aldrich (2020) developed the Social Capital Index (SoCI) as a pragmatic, multidimensional measure designed to capture community-level relational capacity using publicly available data. The SoCI draws directly on this conceptual lineage by operationalizing social capital through three interrelated dimensions: bonding, bridging, and linking. Bonding capital captures inward-looking ties that provide emotional support and mutual aid, bridging capital reflects outward-looking connections across socio-demographic boundaries, and linking capital describes vertical ties between communities and institutions that facilitate access to power, resources, and decision-making structures (Szreter and Woolcock 2004). This tripartite framework is particularly salient in disaster research, where different forms of social capital have been shown to shape preparedness, response, and long-term recovery (Aldrich 2012; Aldrich and Meyer 2015).

The SoCI synthesizes demographic similarity, community organizations, and institutional linkages to capture the relational capacity of U.S. counties. Using publicly available data, the original SoCI operationalized social capital through 19 indicators distributed across the bonding, bridging, and linking domains, each normalized and equally weighted. This approach offered the first systematic, county-level measure of social capital designed specifically for disaster and resilience applications in the United States.

By translating more than a century of conceptual development into a transparent and reproducible indicator system, the SoCI provides a bridge between social theory and applied resilience research. It enables researchers and practitioners to capture the multidimensional nature of social capital at a scale relevant to policy, planning, and hazard mitigation. In doing so, it transforms a rich theoretical tradition into a practical, data-driven tool that has informed research across environmental sciences, public administration, geography, and disaster studies.

3. Tracing the Diffusion of the SoCI

Understanding how the Social Capital Index (SoCI) has circulated through scholarly and applied communities is essential for evaluating its broader impact and situating the index within the evolving landscape of resilience and social capital research. Since its introduction in 2020, the SoCI has been adopted by researchers across a wide range of disciplines, drawn into studies of vulnerability and climate impacts, integrated into analyses of public health and governance, and applied to questions of planning, infrastructure, and disaster response. Examining these diffusion patterns provides insight into how the index is being used, where it has gained the most traction, and how it has contributed to interdisciplinary conversations about social structure and community resilience.

To systematically assess this diffusion, we employ three complementary approaches. First, we analyze disciplinary diffusion (Section 3.1) to identify the fields in which the SoCI has been most widely cited and to understand the breadth of its interdisciplinary reach. Second, we examine annual citation patterns (Section 3.2), using time-series trends to evaluate the pace and trajectory of scholarly uptake over the first five years since publication.

Finally, we conduct a co-citation analysis (Section 3.3) to map the intellectual context in which the SoCI is situated, identifying the foundational theories, methodological traditions, and research communities with which it is most frequently associated. Together, these analyses illuminate not only how widely the SoCI has diffused but also the conceptual networks and disciplinary communities that shape its interpretation and use. By integrating insights from disciplinary distribution, citation trajectories, and co-citation structures, this section provides a comprehensive portrait of the SoCI's influence and its role within the broader scholarly ecosystem concerned with social capital, vulnerability, and resilience.

3.1. *Disciplinary Diffusion of the Social Capital Index (SoCI)*

The disciplinary diffusion analysis shows that the Social Capital Index (SoCI) has achieved broad and diverse uptake across the scientific community, with 91 citing publications distributed across more than twenty fields (Figure 1, Appendix A, Table A1) (Clarivate 2024), and 204 citations recorded by Google Scholar (accessed 15 February 2026). The largest share of citations emerges from meteorology and atmospheric sciences (23 records; 25.3%), demonstrating the index's strong connection to climate-related hazards, extreme weather events, and atmospheric risk assessments. Closely following are environmental studies (19; 20.9%), geosciences multidisciplinary (19; 20.9%), and water resources (19; 20.9%), reflecting substantial integration of the SoCI into research on hydrological hazards, watershed vulnerability, flood risk, and broader earth system processes.

Additional diffusion within environmental sciences (15; 16.5%) and green and sustainable science and technology (7; 7.7%) indicates that the SoCI is increasingly used to examine sustainability transitions, environmental governance, and the social dimensions of climate adaptation. Together, the environmental and physical science categories represent the majority of early uptake, highlighting the central role of social capital in interdisciplinary hazard and climate research.

At the same time, the SoCI has diffused widely across the social sciences and policy-oriented disciplines. Notably, political science, public administration, public and environmental health, sociology, geography, and multidisciplinary sciences each account for 6 records (6.6%), demonstrating consistent engagement across governance, health equity, community resilience, and spatial social science domains. Fields such as regional and urban planning (5; 5.5%) and social sciences interdisciplinary (5; 5.5%) have also incorporated the SoCI, highlighting its relevance for understanding urban inequalities, spatial vulnerability, and planning for resilience.

The index's reach extends into additional applied and professional fields, including urban studies (4; 4.4%), business (3; 3.3%), civil engineering (3; 3.3%), and psychology (3; 3.3%), suggesting growing interest in organizational resilience, infrastructure vulnerability, and psychosocial dimensions of community functioning. More specialized areas, such as construction and building technology, development studies, law, management, and operations research, each contribute 2 citations (approximately 2.2%), reflecting emerging but notable engagement. Even traditionally less connected fields such as agronomy and anthropology have begun referencing the SoCI, each with 1 citation (1.1%), indicating nascent but expanding interdisciplinary crossover.

Collectively, these patterns show that the SoCI is not confined to disaster or resilience studies but has instead become a cross-cutting analytical tool adopted across environmental sciences, public policy, health, planning, engineering, and the broader social sciences. The distribution of citations suggests that the index is valued both for its methodological clarity and for its ability to integrate social structure into analyses of risk, vulnerability, and community well-being. This wide-ranging disciplinary diffusion underscores the

SoCI's growing influence and its role as a bridge between environmental processes, social systems, and institutional structures.

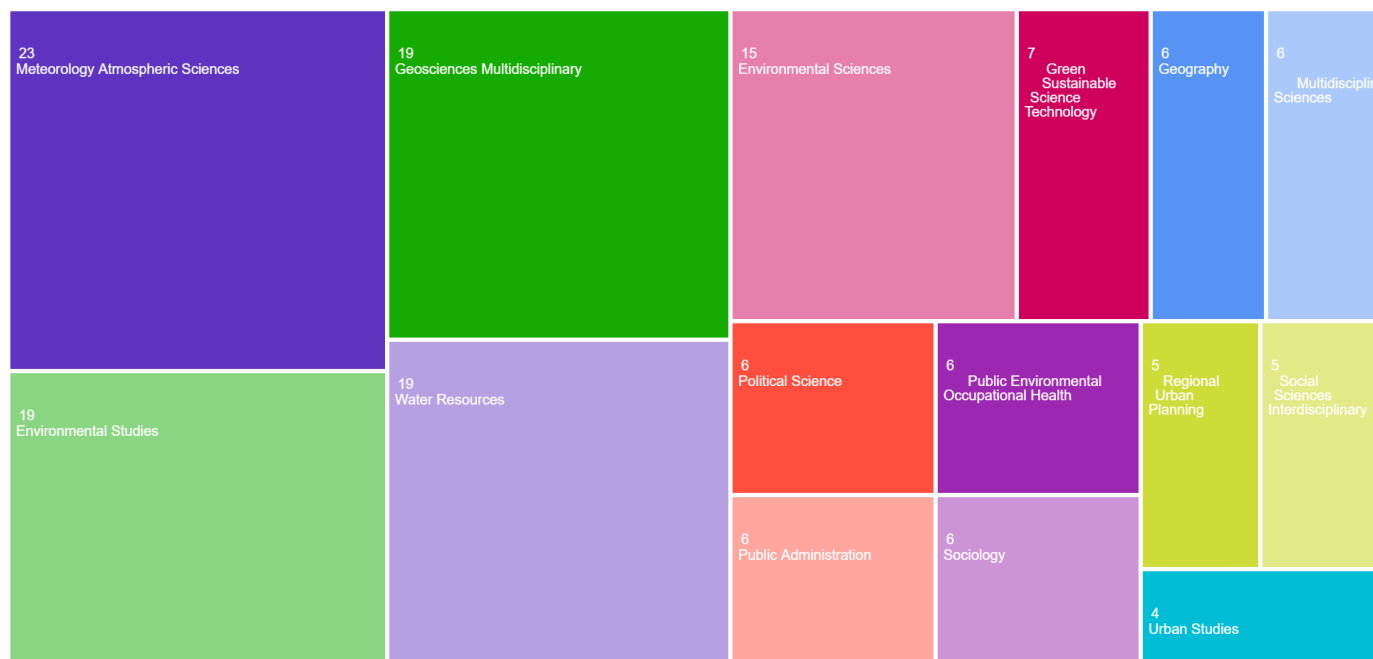


Figure 1. Treemap showing the disciplinary diffusion of the Social Capital Index (SoCI) across 91 Web of Science records. The largest concentrations of citations appear in meteorology and atmospheric sciences, environmental studies, geosciences, and water resources, indicating strong uptake in hazard and environmental research. Additional engagement spans environmental sciences, sustainability studies, geography, political science, public administration, sociology, public health, and urban planning, with smaller contributions from business, engineering, psychology, and other applied fields. The distribution highlights the broad interdisciplinary reach of the SoCI.

3.2. Patterns of Diffusion Reflected in Annual Citations

The citation trajectory of Kyne and Aldrich (2020) demonstrates a clear pattern of rising scholarly engagement since the Social Capital Index (SoCI) was first introduced (Figure 2). Web of Science records show that publications citing the SoCI increased steadily from 2020 to 2024, beginning with 6 citing documents in its release year and rising to more than 20 by 2024 (Clarivate 2024). This growth is mirrored in citation counts, which climbed rapidly from near zero in 2020 to well over 250 cumulative citations by 2024, with the upward trend continuing into 2025.

This pattern indicates not only early uptake but also accelerated diffusion as the index gained visibility across research communities. The sharp increases observed in 2022 and 2023 coincide with the expanding use of the SoCI in environmental sciences, public health, urban planning, disaster research, and interdisciplinary social science fields. Citation behavior suggests that the SoCI has become an increasingly influential methodological tool for analyzing relational capacity, vulnerability, and resilience across U.S. counties.

Overall, the time-series pattern reflects both the growing recognition of the index and the broader shift toward quantitative, composite measures of social capital in resilience and hazard research.

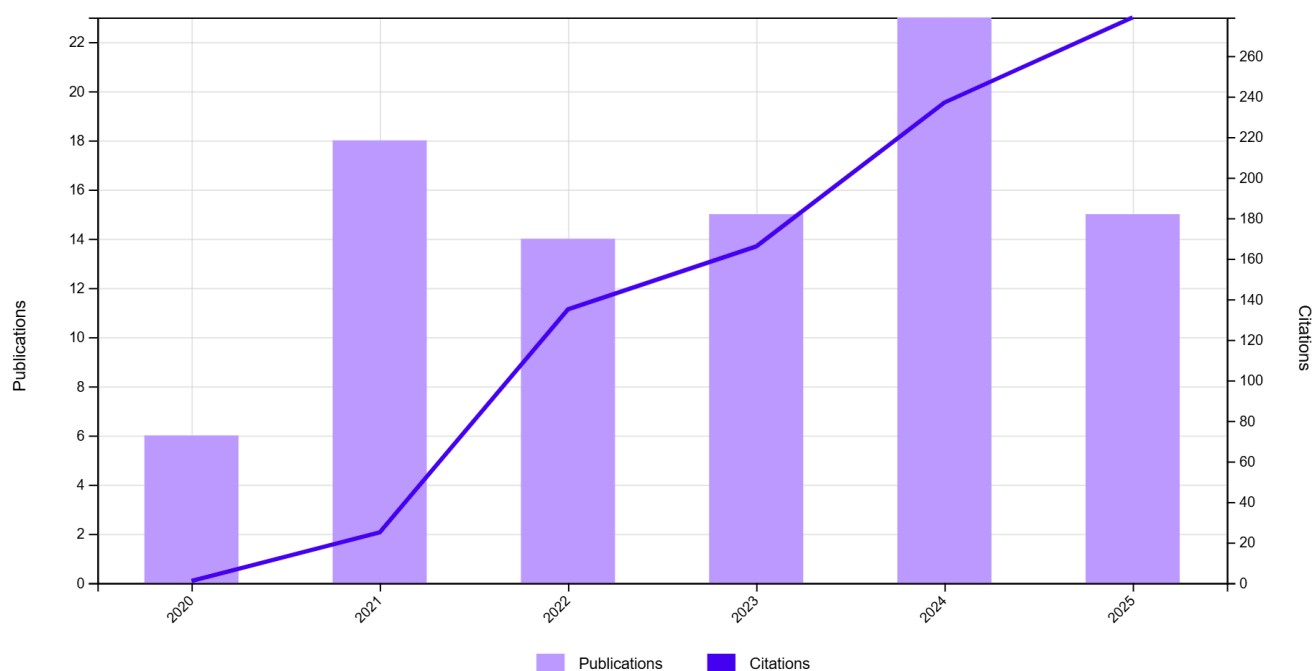


Figure 2. Publications and citations related to the Social Capital Index (SoCI) article (Kyne and Aldrich 2020) from 2020 to 2025 based on Web of Science records. Bars represent the number of citing publications per year, and the line indicates cumulative citation counts. Both metrics show consistent growth, with the steepest increases occurring between 2022 and 2024, reflecting the accelerating scholarly uptake and expanding interdisciplinary use of the SoCI.

3.3. Trajectory of SoCI Diffusion in the Scholarly Literature

Since its publication in 2020, the SoCI article (Kyne and Aldrich 2020) has experienced a steady and accelerating pattern of scholarly uptake. Web of Science records show 91 citations within the first four years, indicating strong early adoption relative to comparable methodological contributions in disaster and resilience research (Clarivate 2024). The citation trajectory demonstrates a clear upward trend, with the highest annual citation counts occurring in 2022–2024, suggesting that engagement with the index is not only growing but expanding into new disciplinary arenas. This expanding intellectual footprint is further illustrated by the co-citation network (Figure 3), which shows how the SoCI has become embedded within multiple scholarly traditions.

Citing documents span fields such as environmental sciences, public health, geography, public administration, urban studies, and sociology, confirming that the SoCI has achieved genuinely interdisciplinary reach. Additionally, citations appear in a range of applied and practitioner-oriented venues, reflecting the index’s utility for emergency management, hazard mitigation, and community resilience assessments. The breadth of citing journals and publication types underscores the SoCI’s value as both a conceptual and methodological contribution.

Taken together, the citation trend data reveal that the SoCI has become a widely recognized and increasingly influential tool for quantifying social capital, with continued growth likely as composite indicators gain prominence in resilience and vulnerability research.

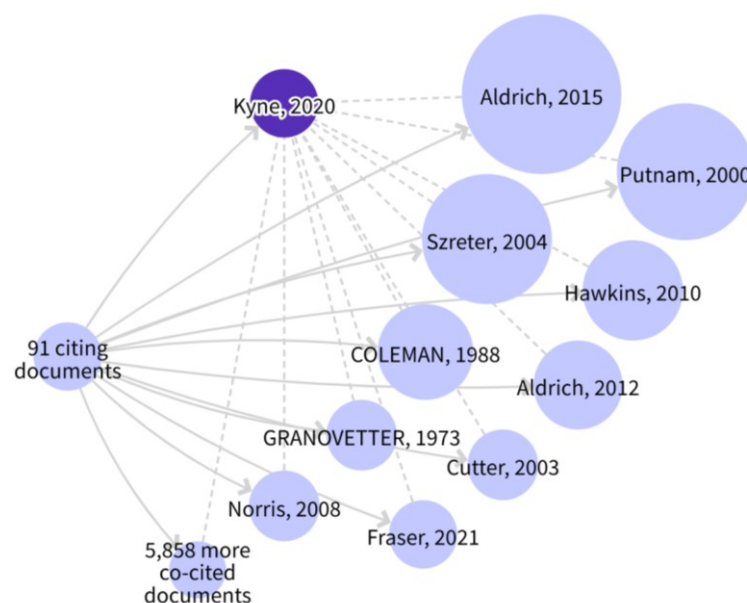


Figure 3. Co-citation network for Kyne and Aldrich (2020) generated from Web of Science records. Node size reflects co-citation frequency, and connecting lines indicate the strength of co-citation relationships. The network reveals strong intellectual clustering around foundational social capital theory (Coleman 1988; Putnam 2000; Sztreter and Woolcock 2004), disaster and resilience research (Aldrich 2012, 2015; Norris et al. 2008; Cutter et al. 2003), and network theory (Granovetter 1973). The central position of the SoCI article and its linkage to more than 5800 co-cited documents demonstrate its bridging role across theoretical, empirical, and applied literatures.

Taken together, the disciplinary diffusion patterns, annual citation trends, and co-citation networks demonstrate that the SoCI has become a widely recognized and increasingly influential tool within the fields of resilience, hazard mitigation, environmental science, public policy, and the broader social sciences. Its rapid uptake across diverse scholarly communities reflects both its conceptual clarity and its practical usefulness for quantifying relational capacity at the county level. Importantly, the co-citation analysis reveals that the SoCI is situated at the intersection of foundational social capital theory, disaster and resilience scholarship, and empirical indicator development, underscoring its function as a bridge between theoretical frameworks and applied research needs.

This expanding influence also highlights the importance of revisiting and strengthening the index to better reflect contemporary data availability, evolving theoretical insights, and the diverse applications emerging across disciplines. Building on the momentum documented in this section, the next part of the paper introduces the updated 2025 version of the Social Capital Index, outlining its expanded indicators, improved normalization procedures, and enhanced conceptual alignment with current research on social structure and community resilience.

4. Advancing Social Capital

Building on the insights gained from early methodological experimentation, the updated 2025 Social Capital Index (SoCI) advances the original framework by integrating new data sources, expanding indicator coverage, and refining the operationalization of bonding, bridging, and linking social capital. These revisions respond directly to conceptual critiques, empirical observations, and lessons learned from the diffusion of the index across diverse disciplinary communities. As scholars increasingly incorporate social capital into analyses of community resilience, hazard vulnerability, and institutional

performance, the need for a more sensitive and comprehensive measurement system has become clear.

The 2022 SoCI reflects this evolution. It incorporates updated 2022 U.S. Census and administrative datasets, adds twelve new indicators across bridging and linking dimensions, and improves the precision of several bonding measures. Together, these enhancements move the SoCI from an inaugural measurement tool to a more mature, theoretically aligned, and empirically robust index capable of supporting longitudinal, spatial, and policy-relevant research. Section 4.2 outlines the construction of the revised index and describes the methodological improvements that distinguish the 2022 version from its 2019 predecessor.

4.1. Early Methodological Experimentation

Since its publication, the SoCI has undergone iterative methodological refinement and conceptual updating. Researchers have expanded indicator sets, improved normalization practices, refined treatments of ACS sentinel values, and incorporated newer measures of associational and institutional ties (Kyne and Aldrich 2020). The transition from the 2010-based index to an updated 2025 version using 2022 data reflects more than a routine data refresh; it represents a substantial strengthening of the measurement framework. These improvements include expanded bridging and linking indicators, more precise operationalization of demographic equality, and closer alignment with contemporary theories of social connectedness and institutional embeddedness (Szreter and Woolcock 2004). This innovation path mirrors the developmental arc described for SoVI, in which the index matured through iterative testing, expanded data inputs, and continuous methodological experimentation (Cutter 1996; Cutter et al. 2003).

The original SoCI was built on the premise that publicly available data could meaningfully approximate bonding, bridging, and linking capital at a national scale. Bonding capital was captured through demographic and socioeconomic similarity, language and communication capacity, and age structure, factors linked to cohesion and mutual support. Bridging capital drew on measures of associational life, including religious, civic, and youth organizations, which provide opportunities for cross-group interaction. Linking capital reflected political and institutional connections, including voter eligibility and government employment, which facilitate access to authority and decision-making structures (Kyne and Aldrich 2020). All variables were normalized to a 0–1 range and equally weighted, following composite indicator best practices where strong theoretical guidance for differential weighting is absent.

Early methodological experimentation focused on three central questions: (1) the stability and behavior of indicators; (2) the sensitivity of the index to alternative weighting and normalization parameters; and (3) the conceptual and spatial coherence of the bonding, bridging, and linking dimensions. Initial analyses revealed that organizational density and institutional ties exhibited greater spatial variability than demographic equality measures, indicating that some elements of social capital are more unevenly distributed across U.S. counties. Exploratory tests using z-scores, alternative standardizations, and selective indicator removal showed that while broad regional patterns remained stable, local classification shifts occurred, highlighting the importance of indicator robustness, a challenge also observed in early SoVI work (Cutter et al. 2003).

Additional analyses examined the independent spatial footprints of bonding, bridging, and linking capital. Bonding capital tended to be concentrated in parts of the Midwest and Northeast, bridging capital was highest in northern and western counties with strong associational networks, and linking capital displayed patterns tied to government employment and civic engagement. These distinct spatial signatures confirmed that the sub-indices captured substantively different dimensions of community social structure.

Finally, early validation tests established a link between SoCI scores and disaster-related outcomes. Kyne and Aldrich (2020) found that higher levels of social capital were associated with fewer fatalities and fewer federal disaster declarations, though results for property damage were less consistent. This pattern, where some outcomes align strongly with index scores and others less so, parallels findings from early SoVI validation literature (Cutter et al. 2003; Finch et al. 2010).

Overall, early methodological experiments demonstrated that the original SoCI was conceptually coherent, empirically interpretable, and sufficiently stable for national-scale analysis. At the same time, they highlighted the need for expanded indicator coverage, particularly within the bridging and linking dimensions, to more fully represent the social infrastructure that shapes community resilience. These insights directly informed the updated 2025 SoCI, which advances the index into a more mature and comprehensive measurement instrument.

4.2. Construction of the Revised 2025 Social Capital Index (SoCI)

The 2025 revision of the Social Capital Index (SoCI) expands and strengthens the measurement framework first developed in the 2020 SoCI by Kyne and Aldrich (2020). Grounded in the well-established tripartite conceptualization of bonding, bridging, and linking social capital (Aldrich 2012; Putnam 2000; Woolcock and Narayan 2000), the updated index incorporates substantial improvements enabled by advances in data availability, indicator refinement, and methodological rigor. Motivated by emerging, higher-resolution county-level datasets and the need for greater analytical precision, the revised SoCI increases the number of indicators from 19 in 2010 to 26 in 2022. The study relies on data from two publicly accessible sources, specifically the 2022 American Community Survey (ACS) (U.S. Census Bureau 2022b) and the 2021 NaNDA dataset (Melendez et al. 2024). The NaNDA dataset is provided at the census-tract level and was collapsed to the county level to align with the unit of analysis used in this study. Table 1 provides a side-by-side comparison of the indicator sets for both versions.

The Social Capital Index (SoCI) is a composite, county-level measure of the relational capacity of communities to mobilize resources, coordinate collective action, and engage with institutions. Conceptually, the SoCI captures the structure and density of social relationships that facilitate cooperation within groups, across groups, and between communities and formal institutions. Empirically, the index operationalizes this construct through observable indicators of bonding, bridging, and linking social capital, aggregated to provide a parsimonious summary of community relational infrastructure.

Bonding social capital refers to the strength of ties among socially similar individuals and groups, characterized by shared identities, close-knit relationships, and inward-looking solidarity. These ties support trust, reciprocity, and mutual aid, particularly during periods of stress or crisis. In the SoCI, bonding social capital is operationalized through indicators of demographic similarity and equality—such as racial income equality and educational equality—which reflect the degree of internal cohesion within communities.

Bridging social capital captures connections that span socially diverse groups, enabling cooperation and information exchange across differences in identity, background, or affiliation. These cross-cutting ties expand access to resources and perspectives beyond homogenous networks and are essential for collective problem-solving at the community scale. In the SoCI, bridging social capital is measured through indicators of associational life, including the density and spatial distribution of civic, religious, youth, and veteran organizations, which function as platforms for intergroup interaction and coordination.

Linking social capital reflects vertical relationships between individuals or community organizations and institutions that hold formal authority, resources, and decision-making power. These ties enable communities to access external support, influence policy

processes, and secure assistance during recovery and reconstruction. In the SoCI, linking social capital is operationalized through indicators of political and institutional embeddedness, including measures of engagement with governmental structures and organizational employment linkages, which serve as proxies for potential access to institutional channels.

Together, these definitions provide the deductive foundation for the construction of the SoCI: observable indicators are selected not as outcomes of social capital but as structural proxies for the presence and configuration of social relationships that constitute bonding, bridging, and linking social capital at the county level.

Bonding Social Capital: The bonding social capital sub-index retains its original ten indicators but benefits from enhanced operationalization. Bonding capital reflects intra-group cohesion, demographic similarity, and inward-looking forms of solidarity (Kyne and Aldrich 2020; Putnam 2000). Although no new variables were added, several indicators underwent methodological refinement to improve accuracy and conceptual alignment. For example, the Racial Income Equality indicator (RINCEQ) was reconstructed to properly handle ACS sentinel values and missingness, and the Educational Equality measure (EDUEQ) was recalculated using a revised transformation procedure that more accurately captures educational disparities. These updates enhance the statistical precision and clarity of the bonding sub-index while maintaining its original conceptual structure. (Appendix C. Calculations for Social Capital Measurements)

Bridging Social Capital: The bridging dimension experienced the most substantial expansion, growing from three indicators in 2020 to eight in 2025. Bridging capital captures cross-group interactions and the organizational structures that facilitate cooperation across diverse populations (Jang et al. 2024; Woolcock 1998). Eight new indicators were added, including normalized measures of civic, youth, veteran, and religious organizations per 1000 residents, as well as new density-based metrics reflecting the geographic distribution of each organizational type. These additions transform the bridging sub-index from a set of simple organizational tallies into a multidimensional representation of associational life that considers both accessibility and spatial concentration. As a result, the 2025 SoCI presents a more comprehensive and empirically rigorous depiction of the relational infrastructure that supports intergroup connectivity.

Linking Social Capital: Linking social capital underwent the most extensive conceptual and empirical enhancement, expanding from two indicators in 2020 to nine in 2025. Linking capital reflects vertical connections between individuals and institutions with authority, resources, and decision-making power (Aldrich 2012; Woolcock and Narayan 2000). The updated index introduces seven new indicators designed to capture institutional embeddedness more fully. These include improved measures of political linkage at local, state, and federal levels, as well as new organizational employment linkage indicators for religious, civic, youth, and veteran-serving institutions (Jang et al. 2024). Collectively, these measures provide a more complete assessment of community members' access to institutional structures and underscore the essential role of linking capital in shaping resilience, resource distribution, and recovery capacity (Kyne and Aldrich 2020).

Index Integration and Normalization: Across bonding, bridging, and linking dimensions, the revised 2025 SoCI incorporates twelve new indicators, resulting in a 26-indicator index with broader conceptual reach and enhanced empirical robustness. All indicators were normalized to a 0–1 range using min–max transformations, merged via county-level FIPS identifiers, and aggregated into their respective bonding, bridging, and linking sub-indices using row totals that accommodate missing data. Consistent with the methodological strategy of the original index (Kyne and Aldrich 2020), the final SoCI score is calculated as the equal-weighted mean of the three sub-index values. This approach

preserves parsimony, ensures comparability across counties, and establishes a forward-compatible foundation for longitudinal extension and future updates (Jang et al. 2024).

To strengthen the conceptual coherence of the index, the twelve new indicators, eight for bridging and four for linking, were added based on a two-step selection process. A comprehensive review of recent social capital scholarship identified specific conceptual gaps in the original index, especially those related to organizational connectivity and institutional embeddedness. In parallel, candidate variables were drawn from publicly available, nationally consistent datasets and evaluated for data quality, theoretical relevance, and temporal compatibility. Only indicators meeting both criteria and avoiding redundancy with existing measures were incorporated into the revised index.

Although the SoCI assigns equal weight to the three subdimensions, the bonding dimension contains more indicators (10) than bridging and linking (8 each), which introduces a minor implicit weighting imbalance. This structure reflects the composition of the original index rather than a theoretical preference for bonding capital. While the expanded set of bridging and linking indicators substantially improves conceptual balance, bonding still contributes slightly more raw information to the overall score. Alternative weighting schemes were examined, including factor-analytic and proportionate weighting, but equal weighting across the three dimensions remained the most theoretically consistent and empirically stable approach. This minor imbalance is therefore acknowledged as a limitation.

The revised SoCI also incorporates data from different years, specifically, 2022 ACS data and 2021 NaNDA organizational data, while some disaster outcomes reflect 2021 conditions. Consequently, the index represents a slightly later snapshot of county-level social capital. Following common practice in resilience and social vulnerability research, SoCI 2022 is treated as a reasonable proxy for pre-existing community conditions, though this temporal mismatch is noted as a limitation.

Further adjustments were required in modeling disaster outcomes. Several dependent variables exhibited zero inflation, particularly in counties with no recorded damages or federal disaster declarations. To address skewness without losing meaningful zero values, the outcomes were transformed using $\log(x + 1)$, which preserves zeroes while reducing the influence of extreme values. Zero-inflated Poisson and negative binomial models were evaluated; however, the log transformation provided the most stable and interpretable basis for comparing SoCI effects across all outcomes.

Taken together, the expanded measurement framework and enhanced methodological rigor of the revised 2025 SoCI not only improve the conceptual clarity of each sub-index but also strengthen the reliability of county-level comparisons nationwide. With all indicators normalized and integrated into a unified scoring system, the index is now better equipped to capture the diverse structural, demographic, and institutional contexts that shape social capital across the United States. Having established the construction and internal logic of the updated SoCI, an important next step is to examine how these refined measures manifest geographically. The following section investigates the spatial distribution of social capital across U.S. counties, revealing distinct regional patterns and disparities that offer critical insight into the geography of community capacity.

Table 1. Indicators of the Social Capital Index (SoCI), 2019 and 2025 Versions. This table summarizes the indicators used to construct the SoCI across its bonding, bridging, and linking dimensions. It lists each variable’s original definition, conceptual basis, and associated data sources, along with the operational forms used in the 2019 index and the updated 2025 revision. The 2025 SoCI integrates new indicators, refined normalization procedures, and 2022 U.S. Census and administrative data to improve measurement accuracy and contemporary relevance.

No.	Variable Code	Social Capital Concept	Study Variable (Original SoCI)	Key Sources	SoCI 2010	SoCI 2022	Data Source (2010)	Data Source (2022)
1	RACSI	Bonding: Race similarity	Race fractionalization	Alesina et al. (1999)	Race similarity	Race similarity	Census 2010	ACS 2022
2	ETHSI	Ethnic similarity	Ethnic fractionalization	Alesina et al. (1999)	Ethnicity similarity	Ethnicity similarity	Census 2010	ACS 2022
3	EDUEQ	Educational equality	College vs. <HS difference	Norris et al. (2008)	Educational equality	Educational equality	Census 2010	ACS 2022
4	INCEQ	Income equality	Gini coefficient	Cutter et al. (2010)	Income equality	Income equality	Census 2010	ACS 2022
5	EMPEQ	Employment equality	Employment parity	Tierney et al. (2001)	Employment equality	Employment equality	Census 2010	ACS 2022
6	RINCEQ	Racial income homogeneity	Racial income fractionalization	Morrow (2008)	—	Racial income homogeneity	Census 2010	ACS 2022
7	GISEQ	Gender income similarity	Gender income fractionalization	Norris et al. (2008)	Gender income similarity	Gender income similarity	Census 2010	ACS 2022
8	LANGC	Language competency	% English proficient	Morrow (2008)	Language competency	Language competency	Census 2010	ACS 2022
9	COMMC	Communication capacity	% households w/ telephone	Cutter et al. (2010)	Communication capacity	Communication capacity	Census 2010	ACS 2022
10	NONEL	Non-elder population	% population < 65	Morrow (2008)	Non-elder population	Non-elder population	Census 2010	ACS 2022
11	RELIG	Religious organizations	Religious orgs per 10k	Chamlee-Wright (2010)	Religious orgs per 10k	Religious orgs per 1k (norm.)	Census 2010	NaNDA 2021
12	CIVIC	Civic organizations	Civic orgs per 10k	Cutter (2016)	Civic orgs per 10k	Civic orgs per 1k (norm.)	Census 2010	NaNDA 2021
13	—	Charitable ties	Charitable membership %	Norris et al. (2008)	Charitable membership	—	ESRI 2017	—
14	—	Fraternal ties	Fraternal membership %	Norris et al. (2008)	Fraternal membership	—	ESRI 2017	—
15	—	Union ties	Union membership %	Norris et al. (2008)	Union membership	—	ESRI 2017	—
16	VETRN	Veteran orgs	—	—	—	Veteran orgs per 1k	—	NaNDA 2021
17	YOUTH	Youth orgs	—	—	—	Youth orgs per 1k	—	NaNDA 2021
18	RELDN	Religious density	—	—	—	Religious org density	—	NaNDA 2021
19	CIVDN	Civic density	—	—	—	Civic org density	—	NaNDA 2021
20	VETDN	Veteran density	—	—	—	Veteran org density	—	NaNDA 2021

21	YUTDN	Youth density	—	—	—	Youth org density	—	NaNDA 2021
22	PLINK	Political linkage	Voting-age eligibility	Morrow (2008)	Political linkage	Political linkage	Census 2010	ACS 2022
23	LOGLK	Local gov linkage	Local gov workforce %	Murphy (2007)	Local gov linkage	Local gov linkage	Census 2010	ACS 2022
24	STGLK	State gov linkage	State gov workforce %	Murphy (2007)	State gov linkage	State gov linkage	Census 2010	ACS 2022
25	FEDLK	Federal linkage	Federal workforce %	Murphy (2007)	Federal linkage	Federal linkage	Census 2010	ACS 2022
26	—	Political activities	Political participation	Tierney et al. (2001)	Political activities	—	ESRI 2017	—
27	RELLK	Religious employment linkage	—	—	—	Religious employment linkage	—	NaNDA 2021
28	CIVLK	Civic employment linkage	—	—	—	Civic employment linkage	—	NaNDA 2021
29	VETLK	Veteran employment linkage	—	—	—	Veteran employment linkage	—	NaNDA 2021
30	YUTLK	Youth employment linkage	—	—	—	Youth employment linkage	—	NaNDA 2021

4.3. Geographic Distribution of the SoCI

Figure 4 presents the national spatial distribution of the updated 2025 Social Capital Index (SoCI) across all 3144 U.S. counties and county equivalents, classified using a five-class standard deviation scheme. One notion is that the number of U.S. counties and county-equivalents increased from 3143 to 3144 in June 2022, when the U.S. Census Bureau formally recognized Connecticut's nine Councils of Governments as county-equivalent units for statistical purposes (U.S. Census Bureau 2022c, 2023). This change is reflected in the 2022 American Community Survey (ACS) and all subsequent federal datasets, and analyses using post-2022 data should adopt the updated total of 3144 county equivalents (U.S. Census Bureau 2022a). The distribution is centered around the national mean: 1320 counties (41.98%) fall within ± 0.5 standard deviations, indicating that most counties exhibit moderate levels of social capital. An additional 683 counties (21.72%) fall between -1.5 and -0.5 SD, while 779 counties (24.78%) fall between $+0.5$ and $+1.5$ SD. At the extremes, 204 counties (6.49%) score below -1.5 SD and 158 counties (5.03%) exceed $+1.5$ SD, reflecting pockets of exceptionally low and high relational capacity.

Low-SoCI counties (< -1.5 SD) form several distinct clusters, most prominently across Central Appalachia, the Deep South, and sections of South Texas. Additional low-SoCI pockets appear in isolated rural areas of the Great Plains and Southwest. These regions share long-documented structural challenges, including limited associational life, constrained institutional presence, and persistent economic disadvantage. Their low scores reflect weaker bridging and linking networks, particularly limited civic infrastructure and sparse nonprofit density.

Counties with moderate to high SoCI scores ($+0.5$ to $+1.5$ SD) are concentrated in the Mountain West, Upper Midwest, and parts of the Northeast and Mid-Atlantic, while the highest-scoring counties ($> +1.5$ SD) form dense clusters in Utah, Idaho, Colorado, Minnesota, Wisconsin, and northern New England. These areas typically exhibit strong civic participation, robust nonprofit sectors, and dense institutional networks, the hallmarks of bridging and linking social capital.

Appendix A, Figure A1 further disaggregates these patterns across the SoCI components. Linking capital is highest in the Mountain West and lowest in Appalachia and the

Deep South, mirroring long-standing differences in governmental capacity and institutional trust. Bridging capital peaks in the Upper Midwest and Mountain West, areas known for dense civic infrastructures. Bonding capital, by contrast, is more evenly distributed, with elevated levels in Utah, Idaho, and select Northeastern counties, reflecting cohesive demographic and cultural structures.

Together, these results reveal substantial spatial variation in the distribution of social capital across the United States. High-SoCI regions are characterized by strong civic ecosystems, diversified organizational infrastructures, and high levels of citizen engagement, whereas low-SoCI regions reflect persistent demographic, economic, and infrastructural barriers to developing bridging and linking networks. These geographic disparities underscore the importance of place-based strategies aimed at strengthening civic infrastructure and institutional connectivity.

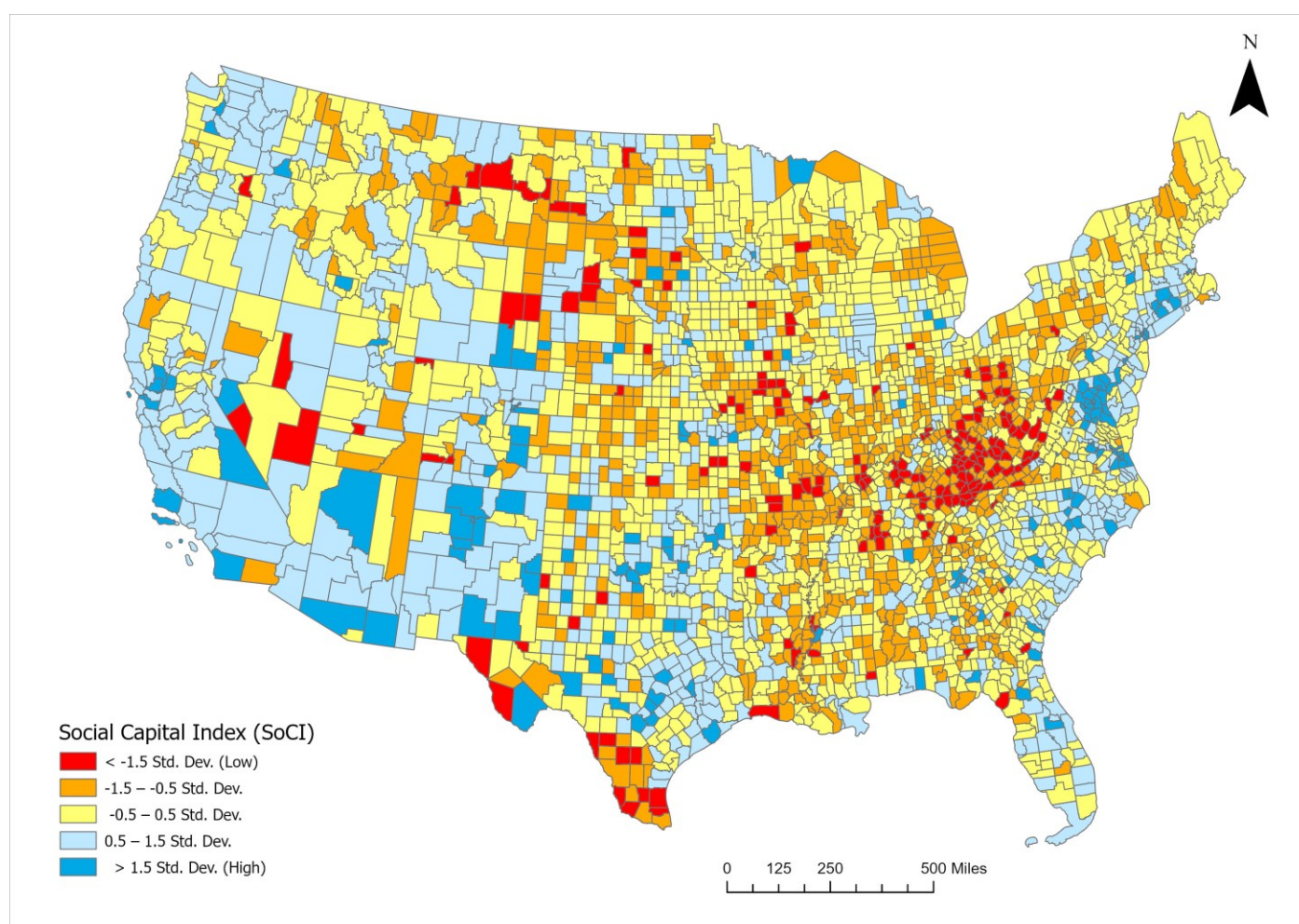


Figure 4. Standard deviation classification of the Social Capital Index (SoCI) across U.S. counties. Counties are grouped into five categories based on their deviation from the national mean SoCI value: very low (<−1.5 SD), low (−1.5 to −0.5 SD), average (−0.5 to 0.5 SD), moderately high (0.5 to 1.5 SD), and very high (>1.5 SD). The map highlights substantial regional variability, with clusters of low social capital concentrated in parts of the South, Appalachia, and select rural regions, while high social capital counties are more prevalent in the Mountain West, Upper Midwest, and portions of the Northeast.

4.4. Comparison of the 2010 and 2022 Social Capital Indexes (SoCIs)

A comparison of the 2010 and 2022 Social Capital Index (SoCI) reveals strong continuity in the overall national distribution of social capital as well as meaningful spatial reconfigurations across U.S. counties (Figure 5, Appendix A, Figure A2). Despite substantial changes in data sources and the expansion from 19 to 26 indicators, the percentile distribution of counties remains essentially unchanged. In both years, approximately 20% of counties fall into the low category, 60% into the medium category, and 20% into the high category, indicating that the broad national landscape of social capital remains structurally stable over time. This stability suggests that bonding, bridging, and linking relationships are deeply rooted in enduring demographic, organizational, and institutional contexts.

At the spatial level, however, the maps demonstrate notable shifts. In 2010, high-SoCI counties were concentrated in the Mountain West, the Upper Midwest, and parts of northern New England, consistent with regions long recognized for strong civic participation, dense nonprofit sectors, and robust community institutions. Low-SoCI counties in 2010 were heavily clustered across Appalachia, the Deep South, and portions of the Southwest, reflecting persistent structural barriers and weaker institutional and associational infrastructures.

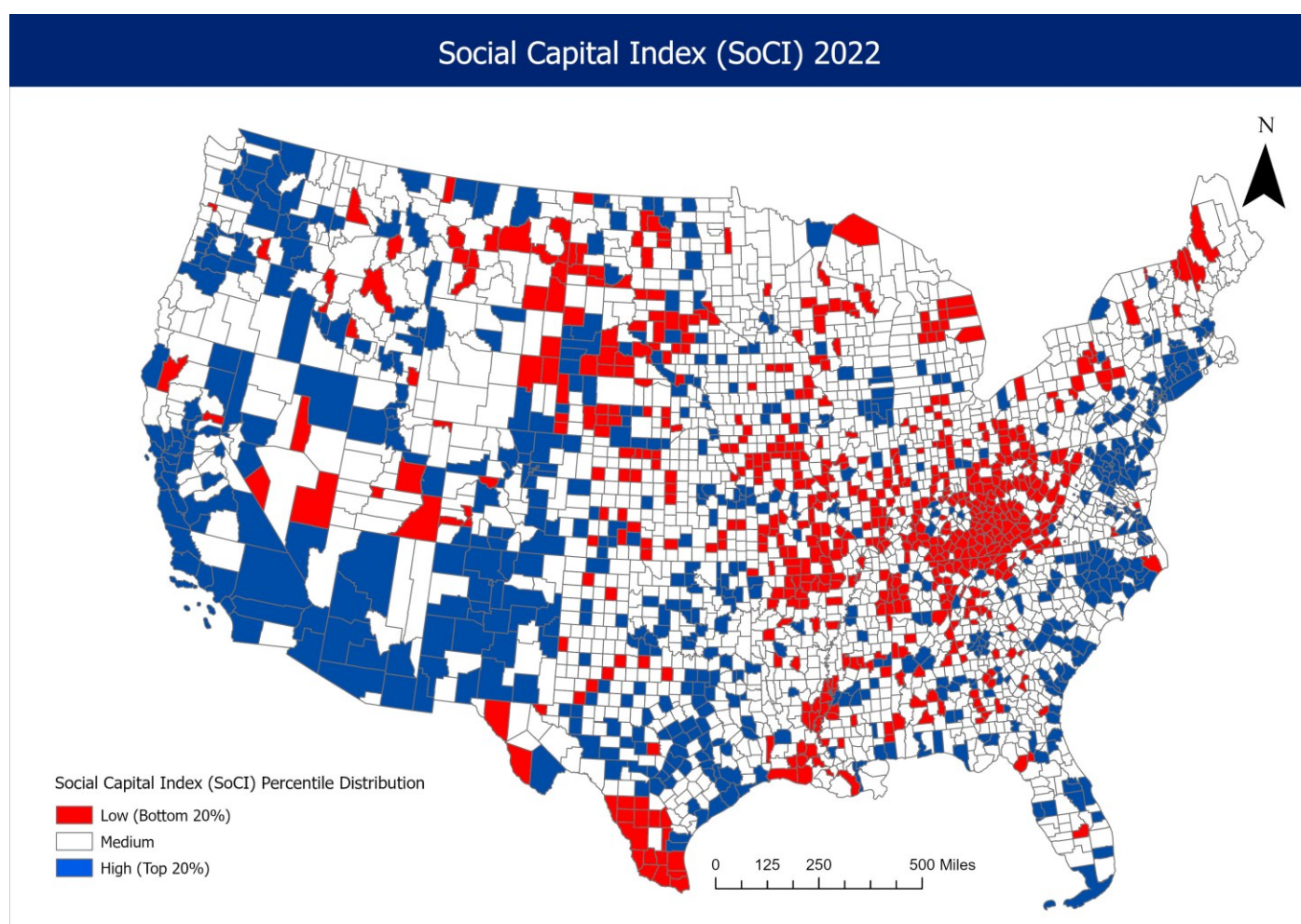


Figure 5. County-level Social Capital Index (SoCI) percentile distribution across the contiguous United States. Counties are classified into three groups based on their SoCI percentile rankings: low (bottom 20%), medium (middle 60%), and high (top 20%). High-SoCI counties are shown in blue, low-SoCI counties in red, and medium-SoCI counties in white. The map illustrates substantial

regional variation in bonding, bridging, and linking social capital, with concentrations of high and low social capital occurring in distinct geographic patterns.

By 2022, several new geographic patterns emerge. High-SoCI counties expanded across much of the western United States, including Oregon, Washington, California, Nevada, Utah, Colorado, and Idaho, forming a broader and more contiguous band of high social capital than observed in 2010. These gains likely reflect growth in civic organizations, expanding nonprofit infrastructures, and strengthened local governance capacity. At the same time, high-SoCI regions persist in the Northeast and parts of the Upper Midwest, though less uniformly than in the previous decade.

Conversely, low-SoCI clusters intensified in Appalachia, the central Deep South, and across the Texas border region, mirroring long-standing structural constraints as well as contemporary demographic pressures and organizational decline. Additional pockets of low social capital appear in isolated rural counties across Arizona, New Mexico, Montana, and the Dakotas. These spatial contractions and expansions point to shifting patterns of population change, economic restructuring, and evolving organizational ecologies.

Despite these regional shifts, medium-SoCI counties remain dominant across the central and interior United States, reflecting broadly moderate but stable levels of relational capacity across much of rural and small-town America.

Taken together, the comparison of the 2010 and 2022 SoCI underscores both continuity and localized transformation in the geography of social capital. While the national percentile structure remains fixed, the movement of specific counties into higher or lower categories highlights the value of routine index updates to capture evolving demographic, institutional, and civic dynamics, particularly in regions undergoing rapid economic or population change. These spatial shifts help identify emerging areas of vulnerability as well as regions where social capital resources have strengthened over time.

4.5. Empirical Validation and Outcome Analysis

Updated validation analysis: This study integrates two primary data sources to examine the relationships among natural disaster losses, social vulnerability, social capital, and community resilience across U.S. counties. The first dataset, *Losses from Natural Disasters*, produced by economists at the Federal Reserve Bank of New York, provides annual county-level estimates of direct damages resulting from natural hazards in the United States (Federal Reserve Bank of New York 2024). These estimates are derived from the National Oceanic and Atmospheric Administration's (NOAA) Storm Events Database, which documents the occurrence, location, duration, and consequences of more than fifty weather and climate hazards. The dataset includes detailed information for each disaster event, including event and episode identifiers, county Federal Information Processing System (FIPS) codes, hazard duration, hazard type, and measures of property and crop damages, as well as direct and indirect injuries and fatalities.

Drawing on a ten-year analytical window spanning 2012–2022, three dependent variables were developed: the natural logarithm of total inflation-adjusted damages ($\ln_dtad$), total injuries ($\ln_injt$), and total fatalities ($\ln_fatt$). Additional covariates were derived to capture population exposure and event frequency, including $\ln_pop$ (county population size), $\ln_evid$ (number of disaster events), and $\ln_days$ (total hazard duration in days). These variables allow for systematic comparison of hazard impacts across counties that vary widely in population and exposure characteristics.

To evaluate the influence of social and community conditions on disaster outcomes, the second dataset incorporates three indices widely used in hazards and emergency management research. The Social Capital Index (SoCI) measures the strength of community networks, civic engagement, and social cohesion, factors that facilitate preparedness,

collective action, and recovery. The Social Vulnerability Index (SoVI) captures demographic and socioeconomic characteristics associated with heightened hazard susceptibility, including poverty, age structure, housing conditions, disability, and linguistic isolation. Finally, the Baseline Resilience Indicators for Communities (BRIC) Index provides a composite assessment of county-level resilience capacity, including economic stability, infrastructural robustness, community competence, and institutional readiness. Together, these indices offer complementary perspectives on the social determinants of disaster impacts, enabling a multidimensional assessment of how community structure, vulnerability, and resilience shape the severity of hazard losses across the United States.

A series of regression models were estimated to assess whether these indices predict three types of disaster outcomes: damages, injuries, and fatalities. Each model regressed one of the outcome variables, $\ln_dtad$, $\ln_injt$, or $\ln_fatt$, on one of the three NRI indices, controlling for population size, event frequency, and event duration. The general specification was

$$Y_i = \beta_0 + \beta_1(\text{Index}_i) + \beta_2 \ln(\text{Population}_i) + \beta_3 \ln(\text{Events}_i) + \beta_4 \ln(\text{EventDays}_i) + \varepsilon_i \quad (1)$$

Three blocks of models were estimated, one each for SoCI, SoVI, and the Resilience Index. All models used robust standard errors and were based on 3144 county-year observations spanning 2010 to 2022.

Prior scholarship guided expectations regarding the anticipated associations of these indices with disaster outcomes. Higher levels of social capital have been linked to increased disaster preparedness and more rapid recovery (Aldrich 2012; Kyne and Aldrich 2020); therefore, SoCI was expected to exhibit negative associations with fatalities and possibly with physical damages, although prior work suggests this relationship may be complex or nonlinear. Based on vulnerability theory and evidence that socially vulnerable populations experience disproportionate hazard impacts (Bakkensen et al. 2017), SoVI was expected to show positive associations with damages, injuries, and fatalities. Because resilience captures the capacity to absorb and recover from shocks, the Resilience Index was expected to display negative associations with all outcome variables (Table 2). Based on this literature, the following hypotheses are proposed and empirically tested.

H1 (Damages): *Disaster-related damages are positively associated with social vulnerability and negatively associated with community resilience, while social capital is expected to exhibit a protective or context-dependent association.*

H2 (Injuries): *Disaster-related injuries are negatively associated with social capital and community resilience and positively associated with social vulnerability.*

H3 (Fatalities): *Disaster-related fatalities are negatively associated with social capital and community resilience and positively associated with social vulnerability.*

Table 2. Hypothesized relationships between three Natural Hazard Risk-related Indices (NRI) and disaster outcomes. Expected signs (β_1) indicate theorized associations between the Social Capital Index (SoCI), Social Vulnerability Index (SoVI), and the Resilience Index and three outcomes—log damages, log injuries, and log fatalities. Hypotheses reflect prior research: SoCI is expected to reduce adverse outcomes, SoVI is expected to increase them, and resilience is expected to mitigate losses.

Outcome of Interest/Indices	SoCI	SoVI	Resilience
H1: Ln Damages	Unknown ($\beta_1 \geq$ or ≤ 0)	Positive ($\beta_1 > 0$)	Negative ($\beta_1 < 0$)
H2: Ln Injuries	Negative ($\beta_1 < 0$)	Positive ($\beta_1 > 0$)	Negative ($\beta_1 < 0$)
H3: Ln Fatalities	Negative ($\beta_1 < 0$)	Positive ($\beta_1 > 0$)	Negative ($\beta_1 < 0$)

The empirical results provide strong evidence for the protective influence of social capital in contemporary disaster contexts while offering more limited support for its earlier-period effects. In the updated 2020 models, the SoCI 2022 index shows a strong and statistically significant association with reduced disaster damages and injuries. Higher levels of social capital are significantly associated with reduced disaster impacts. Specifically, SoCI 2022 is linked to substantially lower total damages ($b = -0.8013$, $SE = 0.3313$, $p < 0.05$) and fewer total injuries ($b = -0.3656$, $SE = 0.0980$, $p < 0.001$). Although the coefficient for fatalities is negative ($b = -0.0928$, $SE = 0.0667$), it does not reach statistical significance, suggesting that while social capital meaningfully dampens property and injury losses, its influence on mortality outcomes is less pronounced (Table 3).

Table 3. Estimated effects of SoCI 2022, SoVI 2022, and BRIC 2020 on disaster damages, injuries, and fatalities (2023). This figure displays regression coefficients and 95% confidence intervals for each index across three disaster outcome models. Positive coefficients (SoVI) indicate higher expected losses, whereas negative coefficients (SoCI and BRIC) reflect protective effects. SoVI shows consistently positive and significant associations with all outcomes, BRIC demonstrates strong protective effects for injuries and fatalities, and SoCI yields significant reductions in damages and injuries. These results highlight differential predictive strengths across indices and emphasize the role of contemporary social capital and community resilience in shaping disaster impacts.

	Ln Damage 2023			Ln Injuries 2023			Ln Fatalities 2023		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SoCI 2022	−1.4114 *** (0.3562)			−0.2326 ** (0.0921)			−0.1324 ** (0.0661)		
SoVI 2022		0.0997 *** (0.0294)			0.0481 *** (0.0091)			0.0351 *** (0.0058)	
BRIC 2020			−0.3981 (0.4402)			−0.6817 *** (0.1370)			−0.7562 *** (0.1001)
Ln Pop 2023	1.0121 *** (0.0648)	0.8860 *** (0.0562)	0.9301 *** (0.0567)	0.3302 *** (0.0154)	0.2976 *** (0.0151)	0.3275 *** (0.0146)	0.2724 *** (0.0117)	0.2510 *** (0.0111)	0.2774 *** (0.0111)
Ln Events 2023	−0.6605 *** (0.1898)	−0.5632 *** (0.1934)	−0.6616 *** (0.1926)	0.3615 *** (0.0445)	0.4149 *** (0.0457)	0.3908 *** (0.0452)	0.0901 *** (0.0298)	0.1296 *** (0.0306)	0.1244 *** (0.0303)
Ln Days 2023	1.1109 *** (0.1178)	0.9750 *** (0.1134)	1.0268 *** (0.1131)	0.1091 *** (0.0290)	0.0654 ** (0.0291)	0.0714 ** (0.0289)	0.1784 *** (0.0195)	0.1483 *** (0.0194)	0.1427 *** (0.0194)
Constant	4.4273 *** (0.6687)	1.9051 *** (0.5680)	3.4680 *** (1.1755)	−4.3780 *** (0.2224)	−4.9884 *** (0.1912)	−3.0661 *** (0.3597)	−3.3635 *** (0.1714)	−3.7583 *** (0.1509)	−1.7384 *** (0.2492)
Observations	3089	3089	3089	3089	3089	3089	3089	3089	3089
R-Square	0.1733	0.1714	0.1686	0.2880	0.2930	0.2924	0.3292	0.3352	0.3425
Adj. R-Square	0.1723	0.1704	0.1675	0.2871	0.2921	0.2914	0.3283	0.3344	0.3417
Log-likelihood	-8.00×10^{03}	-8.00×10^{03}	-8.01×10^{03}	-4.42×10^{03}	-4.41×10^{03}	-4.41×10^{03}	-3.18×10^{03}	-3.17×10^{03}	-3.15×10^{03}
AIC	1.60×10^{04}	1.60×10^{04}	1.60×10^{04}	8850.4702	8828.6788	8831.6658	6378.6107	6350.4548	6316.4081
BIC	1.60×10^{04}	1.60×10^{04}	1.61×10^{04}	8880.6482	8858.8568	8861.8438	6408.7887	6380.6328	6346.5861

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The 2023 regression analyses reveal clear and consistent patterns across the three social indices (Table 3). The updated Social Vulnerability Index (CDC and ATSDR 2022) is positively and significantly associated with all disaster outcomes, including logged damages ($b = 0.0997$, $SE = 0.0294$, $p < 0.001$), injuries ($b = 0.0481$, $SE = 0.0091$, $p < 0.001$), and fatalities ($b = 0.0351$, $SE = 0.0058$, $p < 0.001$). These findings reaffirm that counties exhibiting higher structural vulnerability continue to experience disproportionately greater physical, human, and economic disaster losses.

In contrast, the Social Capital Index (SoCI 2022) is strongly and negatively associated with disaster impacts. Higher levels of social capital correspond to significantly lower logged damages ($b = -1.4114$, $SE = 0.3562$, $p < 0.001$), injuries ($b = -0.2326$, $SE = 0.0921$, $p < 0.01$), and fatalities ($b = -0.1324$, $SE = 0.0661$, $p < 0.01$). These results highlight the protective role of bonding, bridging, and linking social networks in reducing both immediate and severe disaster consequences. Meanwhile, the BRIC 2020 index shows mixed effects—its coefficients are negative but only statistically significant for injuries ($b = -0.6817$, $SE = 0.1370$, $p < 0.001$) and fatalities ($b = -0.7562$, $SE = 0.1001$, $p < 0.001$), suggesting that resilience capacity mitigates human impacts more consistently than economic losses.

Collectively, the 2023 findings demonstrate a coherent and theoretically consistent pattern: structural vulnerability amplifies disaster damages, injuries, and fatalities, while community relational capacity—captured by social capital and selected resilience indicators—serves as an important buffer against both economic losses and human impacts. Overall, the results largely support the study's hypotheses, with social vulnerability consistently increasing disaster losses, social capital significantly reducing adverse outcomes across all measures, and community resilience exhibiting a protective effect for injuries and fatalities.

Predictive Performance of SoCI 2022 for 2021 and 2022 Disaster Outcomes: We also evaluated the predictive validity of the updated Social Capital Index (SoCI 2022) for disaster outcomes in 2021 and 2022 (Appendix A, Tables A2 and A3). Across both years, higher social capital consistently predicted lower damages and fewer injuries. In the 2021 models, SoCI 2022 was strongly associated with reduced damages ($\beta = -1.153$, $p < 0.001$) and injuries ($\beta = -0.295$, $p < 0.001$), while the negative association with fatalities did not reach statistical significance ($\beta = -0.082$, $p = 0.14$). Results for 2022 show a similar pattern: SoCI 2022 significantly reduced damages ($\beta = -0.804$, $p = 0.02$) and injuries ($\beta = -0.366$, $p < 0.001$), whereas the effect on fatalities remained negative but non-significant ($\beta = -0.094$, $p = 0.18$). The consistency of these findings across consecutive years demonstrates the stability of the updated index and its ability to capture social structures that mitigate the human and economic impacts of disasters.

Comparative performance: The comparative results show that the expanded 26-indicator Social Capital Index (SoCI 2022) substantially outperforms the original 19-indicator version (SoCI 2010) in explaining variation in disaster outcomes. The baseline SoCI 2010 models demonstrate limited predictive capability: the index is not significantly associated with 2010 damages ($\beta = -0.063$, $p = 0.772$) or injuries ($\beta = -0.026$, $p = 0.847$), and only a modest protective association emerges for fatalities ($\beta = -0.172$, $p = 0.032$). These patterns indicate that the earlier, narrower indicator set captured only a restricted portion of the social capital dimensions that shape local disaster impacts (Table 4).

By contrast, the updated SoCI 2022 displays stronger and more consistent predictive power for 2020 outcomes. Higher levels of social capital are significantly associated with reduced damages ($\beta = -0.801$, $p = 0.016$) and fewer injuries ($\beta = -0.366$, $p < 0.001$). Although the association with fatalities remains negative, it does not reach statistical significance ($\beta = -0.093$, $p = 0.165$). Even though the magnitude of the 2022 coefficients is somewhat smaller than in earlier provisional models, the sustained direction and significance patterns underscore that the expanded index captures a broader—and more contemporary—set of community capacities, including civic infrastructure, organizational density, and institutional linkages, that collectively support disaster resilience.

As with most observational county-level analyses, the potential for endogeneity warrants caution. Counties with higher social capital may also possess unobserved advantages—such as more effective governance, stronger economic bases, or robust infrastructure—that independently reduce disaster losses. Although the models adjust for population size, hazard frequency, and exposure duration, unmeasured protective factors

may still influence coefficient estimates. To mitigate this risk, we compare findings across three indices (SoCI, SoVI, BRIC) and observe consistent patterns; however, establishing causal inference falls beyond the scope of the present study. Future research employing longitudinal designs or instrumental-variable strategies would help to better isolate the causal mechanisms linking social capital to disaster outcomes.

Taken together, the comparison highlights the analytical value of the expanded SoCI 2022. By incorporating a more diverse and comprehensive set of indicators, the revised index yields a fuller assessment of community social capital and offers improved explanatory power for disaster-related losses relative to the original version. Across both index models, population size, hazard frequency, and hazard exposure duration behave as theoretically expected, further reinforcing the robustness of the empirical framework.

Table 4. Regression Estimates for the Effects of SoCI 2010 and SoCI 2022 on Disaster Outcomes. This table presents ordinary least squares (OLS) regression estimates evaluating the association between the Social Capital Index (SoCI) and logged disaster impacts across U.S. counties. **Panel A** reports estimates using SoCI measured in 2010 to predict 2010 disaster damages, injuries, and fatalities. **Panel B** reports estimates using SoCI measured in 2022 to predict 2023 disaster outcomes. All models adjust for county population size, the number of hazard events, and the cumulative duration of hazard exposure, and robust standard errors are reported. Negative coefficients reflect a protective effect, indicating reductions in disaster losses associated with higher levels of social capital, whereas positive coefficients indicate increased impacts. Statistical significance is denoted by $p < 0.10$, $p < 0.05$, and $p < 0.01$.

Panel A. SoCI 2010 predicting 2010 disaster outcomes

Outcome (log)	Coefficient	p-Value	Direction	Interpretation
Damages 2010	−0.060	0.78	NS	No statistically detectable association
Injuries 2010	−0.030	0.85	NS	No statistically detectable association
Fatalities 2010	−0.176 **	0.03	↓ significant	Higher SoCI 2010 → fewer fatalities

Panel B. SoCI 2022 predicting 2023 disaster outcomes

Outcome (log)	Coefficient	p-Value	Direction	Interpretation
Damages 2023	−1.411 ***	<0.001	↓ significant	Higher SoCI 2022 → substantially fewer damages
Injuries 2023	−0.233 **	0.01	↓ significant	Higher SoCI 2022 → fewer injuries
Fatalities 2023	−0.132 **	0.01	↓ significant	Higher SoCI 2022 → fewer fatalities

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 6 compares the estimated effects of the Social Capital Index from 2010 and 2022 on 2023 disaster damages, injuries, and fatalities, displaying regression coefficients with their 95% confidence intervals. The results show that the original SoCI 2010 offers limited predictive value: its coefficients for damages and injuries are small and statistically insignificant, while only fatalities show a modest protective association.

In contrast, the expanded SoCI 2022 demonstrates substantially stronger and more consistent effects. The coefficients for damages and injuries are significantly negative, with confidence intervals fully below zero, indicating that higher levels of contemporary social capital are associated with fewer economic losses and fewer disaster-related injuries. Although the 2022 coefficient for fatalities is also negative, its confidence interval slightly overlaps the null, suggesting a non-significant association.

Overall, the figure underscores the analytical gains from using the updated 26-indicator SoCI. Compared with the earlier index, SoCI 2022 captures a broader set of civic, organizational, and institutional capacities, yielding a more accurate assessment of how social capital influences disaster outcomes.

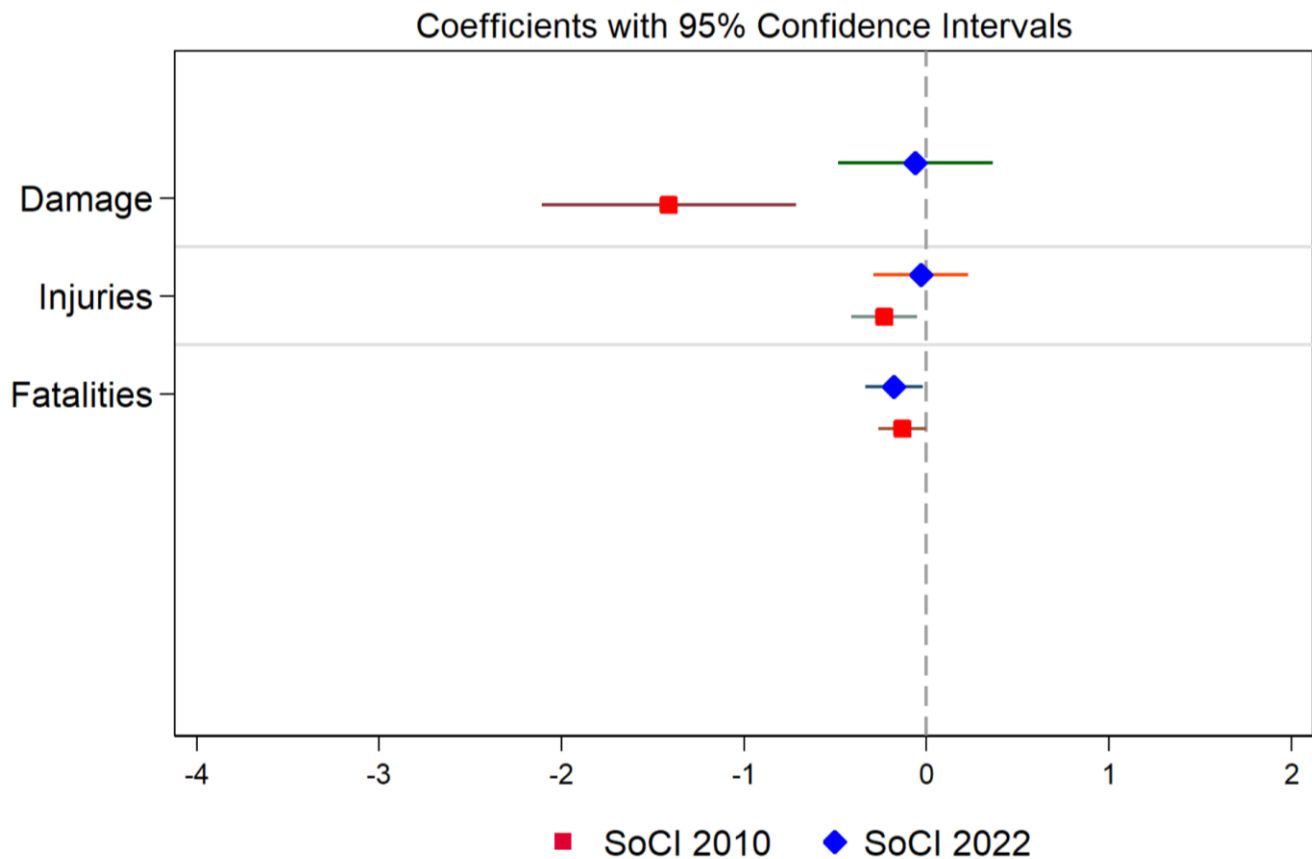


Figure 6. Comparative effects of the Social Capital Index (SoCI) measured in 2010 and 2022 on disaster impacts. Points show regression coefficients for SoCI on property damage, injuries, and fatalities (logged), with 95% confidence intervals. Red squares represent SoCI 2010 effects, and blue diamonds represent SoCI 2022 effects, corresponding to the legend. Negative coefficients indicate reductions in disaster impacts. SoCI 2022 exhibits consistently stronger protective effects across all outcome types, whereas SoCI 2010 shows only modest reductions in fatalities.

4.6. Case Study Illustrations of County-Level Social Capital Change (2010–2022)

To illustrate how substantial gains in county-level social capital can enhance community capacity and institutional connectedness, we highlight three counties that experienced the largest increases in the Social Capital Index (SoCI) between 2010 and 2022: Bronx County (NY), New York County/Manhattan (NY), and Falls Church City (VA) (Table 5, Appendix A, Table A4). These counties registered some of the steepest SoCI improvements nationally and represent urban jurisdictions where demographic change, economic restructuring, and expanding civic and organizational networks have strengthened key dimensions of bonding, bridging, and linking capital. Detailed demographic profiles and component-level indicator changes are provided in Appendices B.4–B.6 and Tables A9–A11.

Bronx County, New York, exhibited one of the sharpest increases, with its SoCI rising from 0.70 in 2010 to 2.76 in 2022 (+2.06; +318%). The county's 2010 profile showed moderate bonding but very weak bridging and linking capital. By 2022, bridging social capital had expanded dramatically—reflecting growth in civic, youth, and community-based organizations—while bonding capital strengthened and linking capital showed modest improvement. These changes unfolded alongside demographic aging, shifts in income parity, and increased ethnoracial concentration, collectively supporting a significant rise in overall SoCI.

New York County (Manhattan), New York, recorded the largest SoCI increase in the nation, rising from 0.89 to 4.04 (+3.15; +365%). Unlike the Bronx, Manhattan began with relatively high levels across all three domains. By 2022, bridging capital had increased to exceptionally high levels, supported by dense civic, cultural, and philanthropic institutions, while bonding capital also strengthened. Linking capital declined slightly but remained comparatively strong. The county's trajectory reflects Manhattan's position as a major economic and organizational hub, with expanded civic mobilization and institutional engagement contributing to markedly higher social capital.

Falls Church City, Virginia, also experienced substantial growth, with its SoCI increasing from 1.19 in 2010 to 3.28 in 2022 (+2.10; +175%). Entering the period with already strong bonding, bridging, and linking capacity, the city achieved balanced gains across all three components. Rising educational and income equality, increased local and state governmental linkage, and improved gender and racial parity contributed to a uniformly strengthened social-capital profile. Falls Church represents a case in which population growth, socioeconomic stability, and strong governance structures reinforce each other to generate broad-based increases in social capital.

Table 5 summarizes these shifts, while Appendices B.4–B.6 provide the underlying demographic and indicator-level detail for each county.

Table 5. SoCI Change Summary for Three Case Counties (2010–2022). Summary of SoCI scores for 2010 and 2022, including absolute and percentage changes and brief profiles of bonding, bridging, and linking capital for Bronx County (NY), New York County (NY), and Falls Church City (VA).

County	SoCI 2010	SoCI 2022	Absolute Change	Percent Change	2010 Profile Summary	2022 Profile Summary
Bronx County, NY	0.7018	2.7627	+2.06	+318%	Moderate bonding; very low bridging and linking; limited civic and institutional networks	Large increase driven by bridging capital (~+6.5 SD); bonding moderate; linking remains weak
New York County, NY	0.8879	4.0392	+3.15	+365%	High bonding/bridging/linking; dense civic and cultural institutions	Exceptional bridging growth (~+6.8 SD); strong bonding; slight decline in linking
Falls Church City, VA	1.1856	3.2835	+2.10	+175%	High across all domains; strong civic participation and governance	Balanced increases in bonding, bridging, linking; 100th percentile nationally

To illustrate how declines in county-level social capital translate into weakened resilience capacity, we highlight the three counties that experienced the largest reductions in the Social Capital Index (SoCI) between 2010 and 2022: Garfield County (MT), Borden County (TX), and King County (TX) (Tables 6 and A5). These counties not only registered the steepest SoCI decreases nationally but also represent rural populations where demographic aging, institutional thinning, and limited civic infrastructure create pronounced vulnerabilities. Detailed profiles, including population dynamics, demographic change, and shifts in normalized SoCI component variables, are provided in Appendices B.1–B.3 and Tables A6–A8.

Garfield County, Montana, experienced the largest proportional decline, with its SoCI falling from 0.96 in 2010 to 0.19 in 2022 (−0.77; −80%). In 2010, the county exhibited modest bonding capital but minimal bridging and linking ties, typical of very small and isolated rural counties. By 2022, even these limited bonding resources had eroded, and bridging and linking capacity remained extremely low, reflecting continued demographic aging, reduced social homogeneity, and limited civic and institutional presence.

Borden County, Texas, showed a nearly identical decline, dropping from 0.94 to 0.18 (−0.76; −81%). The county began 2010 with fragile bonding networks and almost no

bridging or linking capital. Subsequent population loss, declining social similarity, and reductions in organizational and governmental linkage further weakened its already thin civic ecosystem, leaving the county with minimal structural resources to support resilience.

King County, Texas, also experienced a substantial decline, with SoCI decreasing from 0.90 to 0.20 (−0.70; −78%). Despite moderate bonding ties in 2010, the county had very limited bridging and linking capacity. By 2022, both bonding and bridging capital had weakened further, and linking measures—already close to zero—remained unchanged. Persistent depopulation, an aging demographic profile, and the absence of non-profit and governmental institutions contributed to this downward trajectory.

Table 6. SoCI Decline Summary for Three Case Counties (2010–2022). Summary of Social Capital Index (SoCI) scores for 2010 and 2022, showing absolute and percentage decreases and brief profiles of bonding, bridging, and linking capital for Garfield County (MT), Borden County (TX), and King County (TX).

County	SoCI 2010	SoCI 2022	Absolute Change	Percent Change	2010 Profile Summary	2022 Profile Summary
Garfield County, MT	0.9601	0.1923	−0.77	−80%	Modest bonding; very limited bridging and linking; sparse civic and nonprofit infrastructure	Further erosion of bonding; bridging and linking remain minimal; extremely thin organizational and institutional presence
Borden County, TX	0.9372	0.1778	−0.76	−81%	Weak overall social capital supported by a small set of bonding ties; very low organizational density	Bonding declines; bridging and linking remain near zero; shrinking civic and nonprofit footprint
King County, TX	0.9038	0.1993	−0.70	−78%	Moderate bonding; limited bridging and linking; small rural population with few institutions	Declines in both bonding and bridging; linking remains minimal; ongoing population and civic-infrastructure losses

5. Discussion

This study set out to (1) trace the conceptual foundations of the Social Capital Index (SoCI), (2) assess its interdisciplinary diffusion, and (3) advance, validate, and apply an updated SoCI using 2022 data. Together, the findings show that the SoCI is both theoretically grounded and empirically effective as a measure of the geography and consequences of social capital across U.S. counties.

5.1. Conceptual Contributions

The historical and theoretical review demonstrates that the SoCI is grounded in a long intellectual lineage connecting classical social theory, modern social capital scholarship, and contemporary community resilience research. Its tripartite structure—bonding, bridging, and linking capital—draws from foundational contributions by Bourdieu, Coleman, Putnam, and Woolcock, yet adapts these concepts for county-level operationalization. The revised 2025 SoCI strengthens this foundation by expanding indicators of associational life, organizational density, and institutional embeddedness, thereby aligning with current research emphasizing how horizontal ties and vertical linkages jointly shape community resilience (Aldrich and Meyer 2015; Szreter and Woolcock 2004).

At the same time, the conceptual literature underscores that social capital is not universally beneficial. Scholars have long noted that strong bonding ties can take exclusionary or even harmful forms, fostering insularity, in-group favoritism, and reduced information flow (Portes 1998; Portes and Landolt 1996). Such dynamics may concentrate

benefits within tightly knit groups while limiting the participation and support available to marginalized residents (Portes 1998; Portes and Landolt 1996). In disaster contexts, these “negative social capital” effects can impede cross-group coordination, slow response, and reinforce existing social and institutional inequalities (Aldrich 2012; Aldrich and Meyer 2015).

By incorporating bonding, bridging, and linking dimensions, the SoCI reflects this dual conceptual heritage, capturing the cohesive, connective, and institutional dimensions of social capital while recognizing that each may carry both enabling and constraining effects for community resilience.

5.2. Diffusion and Scholarly Impact

Citation and co-citation analyses show that the SoCI has diffused rapidly across disciplines, including environmental sciences, hazards and climate adaptation, public health, public administration, sociology, and urban planning. Co-citation networks place Kyne and Aldrich (2020) at the intersection of foundational social capital theory and empirical resilience research, demonstrating that the SoCI serves as a conceptual and methodological bridge between theoretical debates and applied quantitative work. The steady growth in annual citations indicates that the index now plays a central role in interdisciplinary conversations about vulnerability, resilience, and community capacity.

5.3. Advancing Measurement: Methodological Considerations

The transition from a 19-indicator index in 2010 to a 26-indicator index in 2022 represents a substantive methodological advancement. The expanded SoCI incorporates new indicators capturing civic, youth, veteran, and religious organizations; organizational employment; and political and governmental linkages, thereby reflecting a richer spectrum of associational and institutional ties. Although the core bonding indicators were retained, several were refined to improve conceptual alignment and data quality, including updated measures of educational equality, racial income homogeneity, and communication capacity.

Importantly, the Social Capital Index developed for this study diverges in meaningful ways from widely used alternatives such as the Rupasingha–Goetz and Penn State indices (Rupasingha et al. 2006). Those measures emphasize associational density and formal civic engagement—primarily counting organizational presence, voter turnout, census response, volunteering, and community participation. As a result, they capture institutional civic capacity but only a portion of the broader social capital construct. In contrast, the SoCI integrates bonding, bridging, and linking dimensions by incorporating racial and ethnic similarity, income and educational equality, language competency, political and governmental linkages, and updated organizational densities. This broader framework provides a more multidimensional and hazard-relevant representation of social capital, better suited for explaining variation in disaster impacts.

Several methodological issues warrant further consideration. First, equal weighting was adopted in line with composite-indicator best practices, which recommend uniform weights in the absence of strong theoretical justification for differential weighting. Notably, the expanded 2022 index delivers substantially stronger predictive performance than the original 2010 version, suggesting that the improved coverage meaningfully enhances measurement validity.

Second, data limitations required careful handling rather than routine imputation. Several ACS indicators contain the sentinel value -0.666666 , reflecting suppressed or unreliable estimates due to confidentiality constraints or insufficient sample sizes. Because these values indicate genuine nonreportability, replacing them through imputation would have introduced artificial variation. Similarly, NaNDA organizational indicators include

true zeros for counties that lack civic, youth, veteran, or religious organizations entirely. These zeros represent real structural absences rather than missing data, and imputing alternative values would distort the local civic landscape.

Third, robustness checks demonstrate that findings remain stable across alternative specifications. SoCI coefficients retain their negative direction and substantive magnitude when applying different normalization procedures or when selectively excluding individual indicators, confirming that observed relationships are not artifacts of particular modeling decisions.

Together, these methodological considerations highlight both the rigor and transparency of the updated SoCI while reinforcing its suitability for contemporary resilience and hazard analysis.

5.4. Empirical Validation: Social Capital, Vulnerability, and Resilience

Outcome analyses show that the updated SoCI captures structural dimensions that meaningfully shape disaster impacts. In the 2021 models, higher SoCI scores are associated with significantly lower damages and fewer injuries, even after accounting for population exposure, event frequency, and hazard duration. As anticipated, SoVI is positively associated with losses, confirming that structural vulnerability amplifies disaster impacts, while BRIC demonstrates robust protective effects for injuries and fatalities. Model-fit statistics indicate complementary strengths across the three indices: SoCI most strongly predicts damages, SoVI captures structural disadvantage, and BRIC captures adaptive capacity.

Comparing the 2010 and 2022 SoCIs makes these improvements clear. The 2010 index shows limited predictive power, with only modest associations for fatalities. The expanded 2022 index exhibits stronger and more consistent protective effects, suggesting that the broadened indicator set captures contemporary organizational density, civic capacity, and institutional linkages more effectively. Nevertheless, temporal differences must be interpreted with caution, as they reflect both genuine changes in social capital and improved measurement sensitivity.

Case studies of Bronx County, New York County, and Falls Church City demonstrate these patterns on the ground. The Bronx and Manhattan show dramatic increases driven by explosive growth in bridging capital, reflecting expansion of mutual-aid networks, nonprofits, and civic organizations, while Falls Church exemplifies stable, high-level bonding, bridging, and linking capital. Together, these cases illustrate how civic mobilization, social infrastructure, and institutional engagement contribute to rapid gains in social capital (Fraser et al. 2024; Klinenberg 2018).

A substantial body of economic research demonstrates that social capital contributes to economic performance by reducing transaction costs and facilitating cooperation in markets. Using cross-country data, Knack and Keefer (1997) show that generalized trust and civic norms are strongly associated with higher income growth and investment, independent of education and institutional quality (Knack and Keefer 1997). Extending this logic, the Social Capital Index (SoCI) provides a framework for examining how subnational variation in social capital relates not only to disaster resilience but also to broader patterns of local economic performance and recovery.

At the same time, the richness of the data underlying the Social Capital Index (SoCI) supports multiple complementary interpretations. While the SoCI captures meaningful empirical patterns associated with disaster outcomes, observed correlations may also reflect broader socioeconomic and demographic structures, including income distributions, housing conditions, and population characteristics. Accordingly, outcomes related to disaster impacts, race, income, education, and housing are interpreted as important

community attributes in their own right, without requiring strong claims that they directly represent distinct forms of social capital.

5.5. Policy Applications and Implementation Toolkit

To support practitioners in translating the Social Capital Index into actionable strategies, Table 7 presents a practitioner-focused implementation guide that links SoCI components to concrete planning and policy activities. An essential starting point is to identify priority gaps by examining bonding, bridging, and linking scores to determine where community capacity is weakest. Low bonding capital may indicate a need to strengthen neighborhood cohesion and peer support networks, consistent with evidence that strong interpersonal ties enhance mutual aid and post-crisis recovery (Aldrich and Meyer 2015; Putnam 2000). Low bridging capital highlights opportunities to expand civic associations, volunteer programs, and youth engagement—key pathways for fostering inclusive collective action (Granovetter 1973; Szreter and Woolcock 2004). Weak linking capital, by contrast, signals deficits in institutional trust, representation, and vertical connectivity; in such cases, participatory governance processes and improved government outreach can meaningfully enhance community resilience (McGuire and Silvia 2010; Norris et al. 2008).

Using the bottom 20% of SoCI scores as the threshold for “low social capital” follows established resilience and equity frameworks that designate the lowest quintile as a priority tier for intervention (Cutter et al. 2003; Flanagan et al. 2011). Although normative, this percentile-based cutoff offers a clear and policy-relevant method for identifying counties with weak bonding, bridging, and linking capacity, conditions that elevate disaster vulnerability and impede equitable recovery (Aldrich 2012; Aldrich and Meyer 2015). As such, counties in the lowest quintile represent critical focal points for community resilience programs, hazard communication efforts, and investments in social infrastructure.

A growing body of research underscores the central role of social infrastructure—parks, community centers, libraries, religious institutions, and other public spaces—in shaping these capacities. Such institutions serve as the physical and relational backbone through which communities cultivate bridging and linking networks, support civic participation, and maintain continuity of services during crises (Fraser et al. 2024; Klinenberg 2018). These insights further reinforce the value of integrating SoCI scores into community planning processes.

Building on this foundation, the toolkit highlights several strategic applications. Emergency managers can use SoCI data to prioritize preparedness outreach in communities with low bridging or linking capital, groups that may face barriers to receiving hazard information or accessing emergency resources (Tierney 2014). Planners can incorporate SoCI components into resilience, hazard mitigation, and land-use plans, aligning with recommendations that social infrastructure and social capital be embedded within broader resilience frameworks (Aldrich 2012). Public health agencies can apply SoCI insights to identify populations needing enhanced communication, translation services, or community liaison support, particularly during public health emergencies when information gaps can exacerbate disparities (Kim and Schneider 2008).

Strengthening cross-sector collaboration is equally important. Research shows that resilience improves when local governments, nonprofits, faith organizations, and mutual-aid networks coordinate resources, share information, and build sustained relationships (Chamlee-Wright and Storr 2011; Imperiale and Vanclay 2016). Table 7 encourages practitioners to intentionally cultivate these collaborative networks as part of routine preparedness and long-term resilience planning.

Monitoring change over time also enhances the strategic value of the SoCI. Because social capital evolves through civic-engagement programs, nonprofit expansion, and investments in public spaces, annual or biennial tracking of SoCI scores enables jurisdictions

to evaluate whether social infrastructure and community-building initiatives are producing measurable improvements (Cutter et al. 2010; Fraser et al. 2024).

Finally, the toolkit stresses the need to interpret quantitative SoCI scores alongside qualitative, contextual information. Community feedback, stakeholder interviews, local histories, and ethnographic insights remain essential for capturing informal or culturally embedded forms of social capital—particularly in rural, tribal, and other marginalized communities where relational networks may be strong but not easily quantified (Fine 2010; Portes 1998).

Taken together, these applications demonstrate that when used holistically, the SoCI becomes a powerful decision-support tool that can guide equitable, socially grounded resilience planning. By linking quantitative indicators with qualitative knowledge and local expertise, practitioners can more effectively identify vulnerabilities, strengthen community ties, and build durable capacity for collective action and disaster resilience.

Table 7. Practitioner-Oriented Implementation Toolkit for Applying the Social Capital Index (SoCI). Table 7 provides a practitioner-oriented implementation toolkit for applying the Social Capital Index (SoCI) in policy and planning contexts. The table outlines five action areas, identifying capacity gaps, targeting interventions, strengthening cross-sector collaboration, monitoring trends, and integrating qualitative knowledge, each paired with concrete steps that emergency managers, planners, and public agencies can use to operationalize SoCI findings in community resilience efforts.

Action Area	Practical Steps for Implementation
1. Identify Priority Gaps	☐ Review SoCI sub-index scores (bonding, bridging, linking) to diagnose areas of weak community capacity. ☐ Low bonding: strengthen neighborhood cohesion, peer support groups, cultural associations, and kinship networks. ☐ Low bridging: support nonprofit development, volunteer programs, youth engagement, and civic associations. ☐ Low linking: enhance government outreach, joint planning processes, transparency initiatives, and trust-building efforts.
2. Target Interventions Strategically	☐ Emergency management: prioritize preparedness outreach and risk communication in counties with low bridging or linking capital. ☐ Urban and regional planning: integrate SoCI layers into resilience planning, comprehensive plans, land-use decisions, and hazard-mitigation frameworks. ☐ Public health: use SoCI to identify areas needing stronger communication infrastructure, liaison support, and community health partnerships.
3. Strengthen Cross-Sector Collaboration	☐ Foster partnerships among local governments, nonprofits, faith-based organizations, schools, and mutual-aid networks. ☐ Develop cross-sector working groups to coordinate preparedness, recovery, and resilience initiatives. ☐ Support shared training, resource-sharing agreements, and co-produced community programs.
4. Monitor Change Over Time	☐ Track changes in SoCI values to evaluate the effectiveness of community-engagement and resilience-building initiatives. ☐ Monitor trends within each sub-index (bonding, bridging, linking) to identify where investments are yielding progress or where capacity continues to lag. ☐ Use these trends to inform annual budgeting, grant targeting, and strategic program planning.
5. Combine with Qualitative Knowledge	☐ Interpret SoCI metrics in conjunction with community feedback, resident surveys, participatory workshops, and stakeholder interviews. ☐ Recognize informal, culturally embedded, or place-specific forms of social capital not captured in administrative data.

Action Area	Practical Steps for Implementation
	☐ Avoid reliance solely on numerical indicators, particularly in rural, tribal, immigrant, or linguistically diverse communities.

5.6. Limitations and Future Directions

Several limitations of this study merit recognition and point to important avenues for future research. First, the Social Capital Index (SoCI) is constructed at the community (county) level and therefore captures aggregate relational structures rather than individual-level social ties. While this approach aligns with the study's focus on community capacity and disaster outcomes, it necessarily abstracts from the micro-level relational processes through which social capital is generated and enacted. Developing individual-level measures of social capital and examining how such relationships aggregate into community-level characteristics would offer valuable theoretical and empirical insight. However, comparable individual-level indicators are not currently available through publicly accessible datasets; addressing this gap would likely require the development of a national survey instrument and primary data collection, potentially supported through dedicated federal research funding.

Second, differences in indicator availability between 2010 and 2022 complicate direct longitudinal comparisons of the SoCI. Although the expanded 2022 index demonstrates improved conceptual coverage and predictive validity, future work may benefit from the development of harmonized “core” indicators to support more precise temporal analyses. In addition, county-level measurement may obscure important intra-county variation, particularly in large metropolitan areas where social capital, vulnerability, and resilience can vary substantially across neighborhoods.

Third, the measurement of linking social capital remains an important challenge. While employment-based and institutional indicators provide scalable proxies for institutional presence and potential access, they do not directly capture relational ties between community organizations and governmental actors. Future research would benefit from measures that explicitly assess cross-institutional relationships, such as formal partnerships, collaborative governance arrangements, or repeated interactions between civic groups and public agencies, and from methodologies capable of evaluating the strength and direction of these ties. Advancing such measures will likely require new administrative datasets or primary data collection, but would substantially improve the conceptual and empirical precision of linking social capital assessment.

Fourth, although this study has strengthened the theoretical articulation of social capital and incorporated explicit, testable hypotheses, further work is needed to examine nonlinear relationships, interaction effects, and the dynamic interplay between social capital, social infrastructure, and public policy. Machine-learning approaches, alternative weighting schemes, and disaggregated analyses of bonding, bridging, and linking capital may uncover distinct pathways through which communities build, lose, or transform social capital over time.

Finally, while the SoCI demonstrates applicability across multiple domains, including disaster resilience and economic outcomes, claims regarding its scope and explanatory power should continue to be interpreted with appropriate caution. Observed correlations may reflect broader socioeconomic and demographic structures—such as income distributions, housing conditions, and population characteristics—that shape both social capital and disaster impacts. Future research should continue to explore these alternative interpretations while leveraging the SoCI to examine clearly demonstrable empirical relationships.

Overall, despite these limitations, the expanded 2025 revision of the SoCI offers strong conceptual foundations, enhanced empirical validity, and broad interdisciplinary

relevance. Paired with the Implementation Toolkit, the updated index provides researchers, planners, and policymakers with a robust, theory-driven instrument for diagnosing community capacity, guiding interventions, and advancing equitable resilience across U.S. counties.

6. Conclusions

This study advances the Social Capital Index (SoCI) by reassessing its conceptual foundations, documenting its diffusion across scholarly fields, and introducing a substantially updated 2025 version with an expanded 26-indicator structure. The revised SoCI builds on long-standing theoretical traditions in bonding, bridging, and linking capital, while incorporating new measures that better capture contemporary associational life, civic infrastructure, and institutional connectivity. Empirical analyses demonstrate that the updated index provides a more robust and sensitive measure of community-level social capital, yielding stronger and more consistent associations with disaster impacts and revealing persistent spatial inequalities across U.S. counties.

Looking ahead, the 2025 SoCI provides a foundation for two critical avenues of development. First, state-level SoCI measurement will enable comparisons across broader policy and governance systems, supporting evaluations of how political culture, regulatory environments, and intergovernmental relations shape the production and distribution of social capital. Second, tract-level SoCI measurement will offer fine-grained insight into neighborhood-level relational capacity, helping identify pockets of vulnerability that are obscured by county-level aggregation. With the growing availability of tract-level ACS and administrative data, such multiscalar extensions are both feasible and essential for equity-oriented planning.

Overall, the enhanced SoCI strengthens the ability of researchers, practitioners, and policymakers to diagnose relational capacity, design targeted interventions, and evaluate community resilience. By linking classic social capital theory with contemporary measurement and spatial analysis, the revised SoCI and its future state- and tract-level expansions offer a rigorous, publicly accessible tool for guiding resilience investments, informing hazard mitigation, and supporting the development of more connected, capable, and equitable communities across the United States.

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Abbreviations

The following abbreviations are used in this manuscript:

SoCI	Social Capital Index
SoVI	Social Vulnerability Index
BRIC	Baseline Resilience Indicators for Communities
ACS	American Community Survey
NaNDA	National Neighborhood Data Archive

Appendix A

Table A1. Web of Science disciplinary categories citing the Social Capital Index (SoCI) article (Kyne and Aldrich 2020). The table reports the distribution of 91 citing records across 24 fields, including record counts and the percentage share of total citations (Clarivate 2024). Meteorology and atmospheric sciences show the highest uptake (25.3%), followed by environmental studies, geosciences multidisciplinary, and water resources (each 20.9%). Additional engagement is observed across environmental sciences, sustainability, geography, political science, public administration, sociology, public health, and urban planning, with smaller contributions from business, engineering, psychology, and other applied fields. The distribution highlights the broad interdisciplinary diffusion of the SoCI.

No.	Web of Science Categories	Record Count	% of 91
1	Meteorology Atmospheric Sciences	23	25.275
2	Environmental Studies	19	20.879
3	Geosciences Multidisciplinary	19	20.879
4	Water Resources	19	20.879
5	Environmental Sciences	15	16.484
6	Green Sustainable Science Technology	7	7.692
7	Geography	6	6.593
8	Multidisciplinary Sciences	6	6.593
9	Political Science	6	6.593
10	Public Administration	6	6.593
11	Public Environmental Occupational Health	6	6.593
12	Sociology	6	6.593
13	Regional Urban Planning	5	5.495
14	Social Sciences Interdisciplinary	5	5.495
15	Urban Studies	4	4.396
16	Business	3	3.297
17	Engineering Civil	3	3.297
18	Psychology Multidisciplinary	3	3.297
19	Construction Building Technology	2	2.198
20	Development Studies	2	2.198
21	Law	2	2.198
22	Management	2	2.198
23	Operations Research Management Science	2	2.198
24	Agronomy	1	1.099
25	Anthropology	1	1.099
Total Records		173	

Table A2. Estimated effects of SoCI 2022, SoVI 2022, and BRIC 2020 on disaster damages, injuries, and fatalities (2021). This table presents regression estimates assessing the predictive performance of three major social indices—SoCI 2022, SoVI 2022, and BRIC 2020—for logged disaster damages, injuries, and fatalities reported in 2022. Coefficients represent standardized effects with robust

standard errors in parentheses. Positive coefficients (as observed for SoVI) indicate higher expected disaster losses, whereas negative coefficients (as observed for SoCI and BRIC) reflect protective associations.

	Ln Damages (2021)			Ln Injuries (2021)			Ln Fatality (2021)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SoCI 2022	−1.1533 *** (0.3148)			−0.2945 *** (0.1004)			−0.0816 (0.0678)		
SoVI 2022		0.1012 *** (0.0295)			0.0577 *** (0.0094)			0.0368 *** (0.0058)	
BRIC 2020			−0.4191 (0.4037)			−0.9055 *** (0.1410)			−0.8162 *** (0.0956)
Ln Pop 2021	0.8631 *** (0.0573)	0.7501 *** (0.0523)	0.7971 *** (0.0499)	0.3691 *** (0.0162)	0.3277 *** (0.0155)	0.3659 *** (0.0153)	0.2843 *** (0.0114)	0.2647 *** (0.0110)	0.2931 *** (0.0109)
Ln Events 2021	−0.3746 ** (0.1748)	−0.2650 (0.1877)	−0.3713 ** (0.1828)	0.3748 *** (0.0452)	0.4430 *** (0.0467)	0.4161 *** (0.0458)	0.1125 *** (0.0290)	0.1575 *** (0.0301)	0.1526 *** (0.0296)
Ln Days 2021	0.6563 *** (0.0948)	0.5351 *** (0.0975)	0.5886 *** (0.0968)	0.1260 *** (0.0300)	0.0729 ** (0.0303)	0.0770 ** (0.0299)	0.1543 *** (0.0188)	0.1252 *** (0.0190)	0.1183 *** (0.0189)
Constant	7.1262 *** (0.6378)	4.9210 *** (0.5572)	6.5497 *** (1.0545)	−4.7000 *** (0.2366)	−5.4617 *** (0.2020)	−2.9443 *** (0.3789)	−3.5412 *** (0.1710)	−3.8815 *** (0.1458)	−1.7073 *** (0.2445)
Observations	3089	3089	3089	3089	3089	3089	3089	3089	3089
R-Square	0.1469	0.1465	0.1429	0.2982	0.3043	0.3051	0.3346	0.3415	0.3500
Adj. R-Square	0.1458	0.1454	0.1418	0.2973	0.3034	0.3042	0.3338	0.3406	0.3492
Log-likelihood	-7.66×10^{03}	-7.66×10^{03}	-7.67×10^{03}	-4.58×10^{03}	-4.56×10^{03}	-4.56×10^{03}	-3.24×10^{03}	-3.23×10^{03}	-3.21×10^{03}
AIC	1.53×10^{04}	1.53×10^{04}	1.53×10^{04}	9165.0389	9138.0114	9134.6055	6494.8602	6462.9448	6422.5511
BIC	1.54×10^{04}	1.54×10^{04}	1.54×10^{04}	9195.2169	9168.1894	9164.7835	6525.0382	6493.1228	6452.7291

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A3. Estimated effects of SoCI 2022, SoVI 2022, and BRIC 2020 on disaster damages, injuries, and fatalities (2022). This table presents regression estimates assessing the predictive performance of three major social indices—SoCI 2022, SoVI 2022, and BRIC 2020—for logged disaster damages, injuries, and fatalities reported in 2022. Coefficients represent standardized effects with robust standard errors in parentheses. Positive coefficients (as observed for SoVI) indicate higher expected disaster losses, whereas negative coefficients (as observed for SoCI and BRIC) reflect protective associations.

	Ln Damage 2022			Ln Injuries 2022			Ln Fatalities 2022		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
SoCI 2022	−0.8041 ** (0.3313)			−0.3657 *** (0.0980)			−0.0943 (0.0667)		
SoVI 2022		0.0781 ** (0.0313)			0.0496 *** (0.0089)			0.0339 *** (0.0057)	
BRIC 2020			0.0466 (0.4475)			−0.7393 *** (0.1358)			−0.7548 *** (0.0976)
Ln Pop 2022	0.8887 *** (0.0636)	0.8075 *** (0.0575)	0.8364 *** (0.0563)	0.3517 *** (0.0154)	0.3094 *** (0.0150)	0.3414 *** (0.0146)	0.2773 *** (0.0116)	0.2584 *** (0.0111)	0.2847 *** (0.0112)
Ln Events 2022	−0.2852 (0.1881)	−0.2078 (0.1951)	−0.2988 (0.1932)	0.3723 *** (0.0428)	0.4235 *** (0.0441)	0.4004 *** (0.0434)	0.1137 *** (0.0287)	0.1509 *** (0.0294)	0.1463 *** (0.0290)
Ln Days 2022	0.6935 *** (0.1082)	0.6091 *** (0.1079)	0.6575 *** (0.1084)	0.1129 *** (0.0283)	0.0661 ** (0.0283)	0.0697 ** (0.0281)	0.1461 *** (0.0186)	0.1214 *** (0.0186)	0.1150 *** (0.0186)
Constant	4.9628 *** (0.6732)	3.3839 *** (0.5752)	3.7640 *** (1.2033)	−4.3398 *** (0.2267)	−5.1462 *** (0.1927)	−3.0749 *** (0.3586)	−3.4287 *** (0.1723)	−3.7693 *** (0.1499)	−1.7598 *** (0.2451)

Observations	3089	3089	3089	3089	3089	3089	3089	3089	3089
R-Square	0.1382	0.1385	0.1366	0.2986	0.3022	0.3021	0.3299	0.3359	0.3437
Adj. R-Square	0.1371	0.1374	0.1355	0.2977	0.3013	0.3012	0.3291	0.3351	0.3428
Log-likelihood	-8.02×10^3	-8.02×10^3	-8.02×10^3	-4.42×10^3	-4.41×10^3	-4.41×10^3	-3.19×10^3	-3.17×10^3	-3.15×10^3
AIC	1.61×10^4	1.61×10^4	1.61×10^4	8842.3183	8826.4460	8826.7854	6383.3279	6355.5299	6319.4285
BIC	1.61×10^4	1.61×10^4	1.61×10^4	8872.4963	8856.6241	8856.9634	6413.5060	6385.7079	6349.6065

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4. Bottom ten U.S. counties based on Social Capital Index (SoCI) percentile rankings.

No.	County	State	SoCI2022	Rank
1	Zapata	Texas	1.6669	3135
2	Holmes	Ohio	1.6666	3136
3	Noble	Ohio	1.6534	3137
4	Mingo	West Virginia	1.6413	3138
5	Hudspeth	Texas	1.6393	3139
6	Kenedy	Texas	1.6159	3140
7	Menifee	Kentucky	1.6047	3141
8	Oglala Lakota	South Dakota	1.5988	3142
9	Calhoun	West Virginia	1.5967	3143
10	Esmeralda	Nevada	1.5205	3144

Table A5. Top ten U.S. counties based on Social Capital Index (SoCI) percentile rankings.

No.	County	State	SoCI2022	Rank
1	Kalawao	Hawaii	4.1059	1
2	New York	New York	4.0392	2
3	Falls Church	Virginia	3.2835	3
4	Alexandria	Virginia	3.2341	4
5	District of Columbia	District of Columbia	3.1955	5
6	Kings	New York	3.1817	6
7	Arlington	Virginia	3.1508	7
8	Los Alamos	New Mexico	3.1138	8
9	Fredericksburg	Virginia	3.0239	9
10	San Francisco	California	2.9914	10

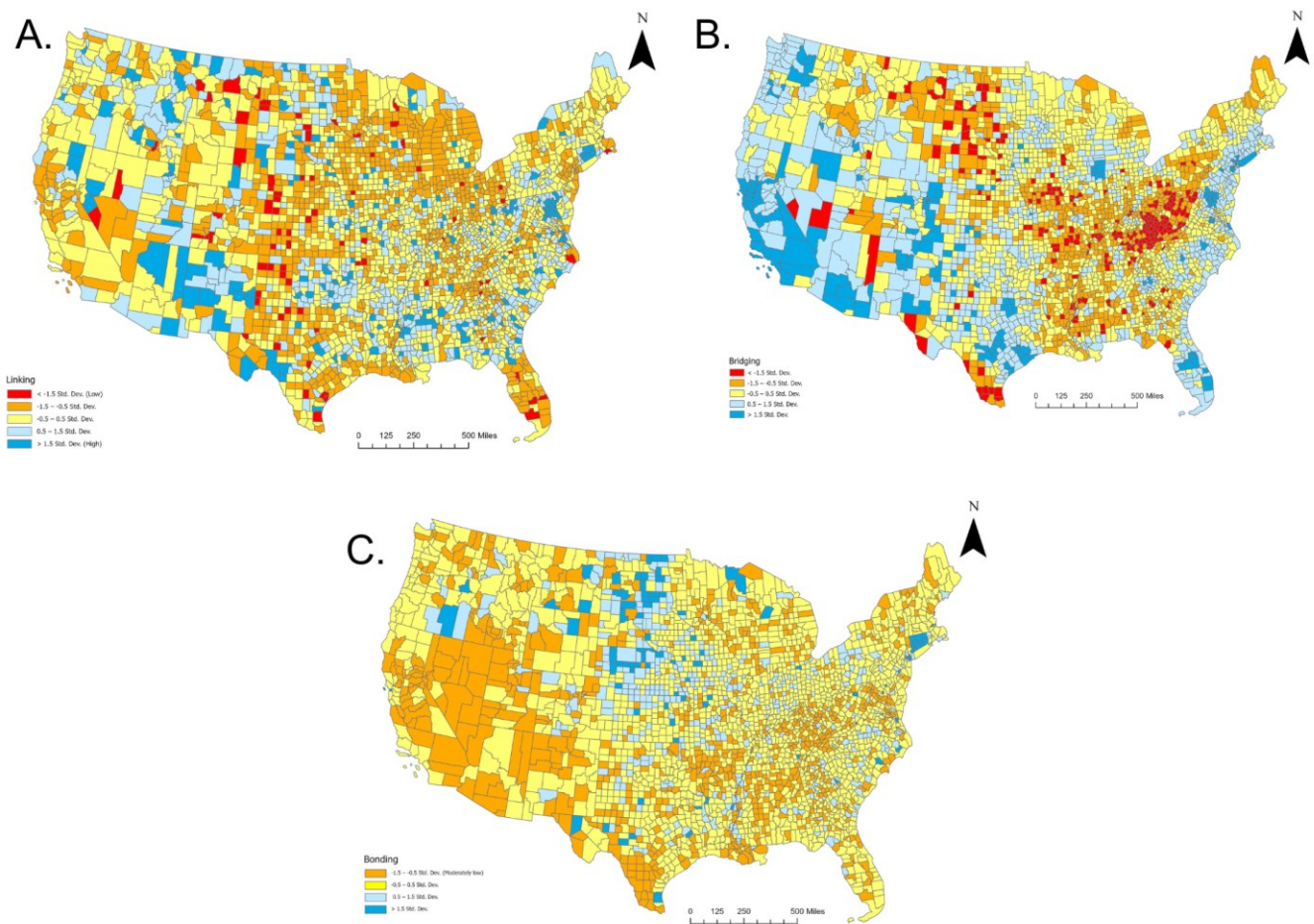


Figure A1. Standard deviation maps of the three dimensions of the Social Capital Index (SoCI) across U.S. counties. **(A)** Linking social capital, representing institutional ties and vertical relationships with government and organizational structures. **(B)** Bridging social capital, reflecting cross-group associations and organizational connectivity. **(C)** Bonding social capital, capturing intra-group cohesion and demographic similarity. Each map classifies county-level values using standard deviation categories relative to the national mean: very low (<-1.5 SD), low (-1.5 to -0.5 SD), average (-0.5 to 0.5 SD), moderately high (0.5 to 1.5 SD), and very high (>1.5 SD). The maps illustrate distinct spatial patterns for each dimension, revealing strong geographic clustering and variation in the structural components of social capital across the United States.

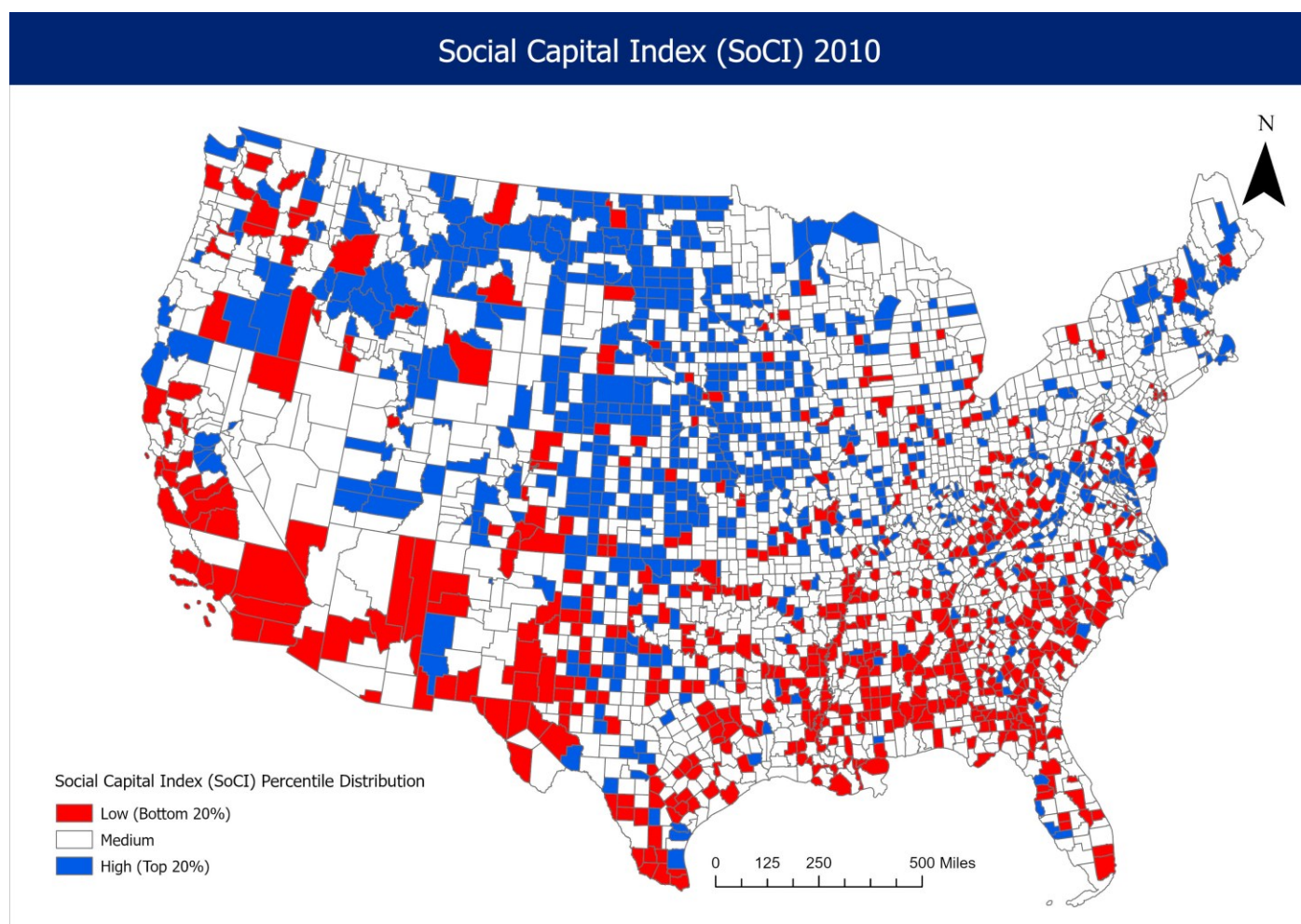


Figure A2. Social Capital Index (SoCI), 2010 (Percentile Distribution). County-level Social Capital Index (SoCI) scores for 2010 classified into three percentile-based categories: low (bottom 20%), medium (middle 60%), and high (top 20%). High-SoCI counties are concentrated in the Mountain West, Upper Midwest, and northern New England, while low-SoCI counties cluster across Appalachia, the Deep South, and parts of the Central Plains and Southwest.

Appendix B. Counties Exhibiting the Greatest Increases and Declines in the Social Capital Index (SoCI), 2010–2022

Appendix B.1. Garfield County, Montana

Garfield County, Montana, one of the most sparsely populated counties in the United States, experienced only modest demographic change between 2010 and 2022. According to U.S. Census Bureau estimates, the county's population grew from 1192 to 1218 over the period, an increase of 2.2%, far below the national (+7.7%) and state (+13.3%) averages (USA Facts 2022d). Annual changes varied sharply, with the largest increase occurring in 2011 (+5.2%) and the steepest decline in 2020 (−8%). The county also became marginally more diverse, with the Hispanic/Latino population rising from 3 to 13 residents, while the White non-Hispanic share decreased from 98.5% to 96.5%. Age structure shifted substantially: the 65+ population grew by 36% (from 20.7% to 25.6%), whereas the 20–34 age cohort declined by nearly 10%. This combination of demographic aging, slight diversification, and stable population size forms the broader context in which changes in Garfield County's social capital components must be interpreted.

Correspondingly, several core components of the Social Capital Index (SoCI) changed dramatically between 2010 and 2022. Indicators reflecting demographic structure

and social homogeneity showed sharp declines—including non-elder population share (−99.99%), ethnic similarity (−100%), and racial income homogeneity (−100%)—consistent with the county’s aging profile and small but notable diversification. In contrast, measures related to economic and political equality improved over the same period. Employment equality (+21%), income equality (+2.9%), gender income similarity (+211%), and local government linkage (+26%) all increased substantially. These patterns align with the demographic and economic volatility characteristic of extremely small rural counties, where the addition or departure of a few households can produce large proportional shifts in normalized indicators. Together, the results show that while Garfield County remains very small, aging, and sparsely populated, its socioeconomic and civic characteristics have become more heterogeneous, illustrating how even minimal demographic changes can amplify statistical variation in standardized social capital metrics.

Table A6. Changes in Social Capital Components in Garfield County, Montana (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

Garfield County, Montana		2010	2022	Absolute Change	Pct. Change
Population	Population	1206	1221	15	1.24
COMMC	Communication Capacity	0.9170	0.9792	0.0622	6.78
NONEL	Non-Elder Population (Share Under 65)	0.9689	0.0001	−0.9688	−99.99
EDUEQ	Educational Equality	0.7098	0.6245	−0.0852	−12.01
LANGC	Language Competency	0.9812	0.9976	0.0164	1.67
ETHSI	Ethnic Similarity	0.9914	0.0000	−0.9914	−100.00
EMPEQ	Employment Equality	0.7197	0.8715	0.1518	21.09
INCEQ	Income Equality	0.5753	0.5920	0.0167	2.90
GISEQ	Gender Income Similarity	0.1728	0.5379	0.3650	211.21
RINCEQ	Racial Income Homogeneity	1.0000	0.0000	−1.0000	−100.00
LOGLK	Local Government Linkage	0.3824	0.4829	0.1005	26.28
STGLK	State Government Linkage	0.0359	0.0366	0.0007	2.00
FEDLK	Federal Government Linkage	0.0954	0.0453	−0.0500	−52.46

Appendix B.2. Borden County, Texas

Borden County, Texas, a sparsely populated rural county in West Texas, experienced a population decline of 9.4% between 2010 (≈646 residents) and 2022 (581 residents), in contrast to growth in both Texas (+19%) and the United States (+7.7%) during the same period (USA Facts 2022a). This long-term population contraction was accompanied by marked demographic aging, including growth in the 65+ population and sharp declines in the 35–49 age cohort. These demographic shifts provide essential context for interpreting changes in the county’s normalized Social Capital Index (SoCI) components, as small and aging populations are particularly sensitive to proportional changes in social and institutional indicators.

Between 2010 and 2022, several SoCI indicators for Borden County declined substantially. The non-elder population share (NONEL) dropped nearly to zero (−99.99%), while ethnic similarity (ETHSI) decreased by 72% and racial income homogeneity (RINCEQ) fell from 1.0000 to 0. These declines were accompanied by reductions in communication capacity (−5.07%), gender income similarity (−28.6%), local government linkage (−34.6%), and federal linkage (−100%). At the same time, certain equality-related indicators improved: educational equality increased (+16%), income equality rose sharply (+78%),

employment equality remained stable, and state linkage strengthened (+49%). Despite these gains, the large declines in demographic composition, social similarity, and institutional connectivity outweighed improvements, producing an overall lower SoCI score for 2022. This pattern underscores how even modest demographic or economic changes in very small rural counties can translate into large proportional shifts in normalized social capital metrics.

Table A7. Changes in Social Capital Components in Borden County, Texas (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

Borden County, Texas		2010	2022	Absolute Change	Pct. Change
Population	Population	641.0000	581.0000	−60.0000	−9.36
COMMC	Communication Capacity	0.8852	0.8403	−0.0449	−5.07
NONEL	Non-Elder Population (Share Under 65)	0.9355	0.0001	−0.9354	−99.99
EDUEQ	Educational Equality	0.6741	0.7851	0.1110	16.46
LANGC	Language Competency	0.8981	0.9456	0.0475	5.29
ETHSI	Ethnic Similarity	1.0000	0.2802	−0.7198	−71.98
EMPEQ	Employment Equality	0.6436	0.6441	0.0005	0.08
INCEQ	Income Equality	0.3265	0.5808	0.2543	77.91
GISEQ	Gender Income Similarity	0.7163	0.5114	−0.2048	−28.60
RINCEQ	Racial Income Homogeneity	1.0000	0.0000	−1.0000	−100.00
LOGLK	Local Government Linkage	0.3832	0.2506	−0.1326	−34.60
STGLK	State Government Linkage	0.1611	0.2395	0.0784	48.68
FEDLK	Federal Government Linkage	0.2274	0.0000	−0.2274	−100.00

Appendix B.3. King County, Texas

King County, Texas, one of the most sparsely populated counties in the United States, experienced a sharp population decline from roughly 286–288 residents in 2010 to 233 in 2022, a decrease of about 19%, in contrast to strong statewide (+19%) and national (+7.7%) growth over the same period (USA Facts 2022e). As of the 2020 Census, the county had 265 residents, making it the second-least populous county in Texas. With no incorporated communities and a county seat that exists only as a census-designated place, King County’s extremely small, aging, and dispersed population provides the structural context for interpreting shifts in its social capital indicators.

Several SoCI variables declined substantially between 2010 and 2022. The non-elder population share (NONEL) dropped from 0.8601 to 0, educational equality (EDUEQ) fell by 51.6%, language competency (LANGC) by 24.05%, employment equality (EMPEQ) by 37.26%, and racial income homogeneity (RINCEQ) from 1.0000 to 0, indicating reduced demographic uniformity. Local government linkage (LOGLK) also declined by 17.98%. At the same time, communication capacity (COMMC) increased to 1.0000 (+30.87%), ethnic similarity (ETHSI) rose by 51.71%, gender income similarity (GISEQ) nearly doubled (+93.81%), and income equality (INCEQ) increased modestly (+6.05%). These contrasting movements—declining demographic stability and economic parity alongside gains in communication access and selected equality measures—capture the complex transformation of King County’s social capital landscape between 2010 and 2022.

Table A8. Changes in Social Capital Components in King County, Texas (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

King County, Texas		2010	2022	Absolute Change	Pct. Change
Population	Population	286.0000	233.0000	−53.0000	−18.53
COMMC	Communication Capacity	0.7641	1.0000	0.2359	30.87
NONEL	Non-Elder Population (Share Under 65)	0.8601	0.0000	−0.8601	−100.00
EDUEQ	Educational Equality	0.8951	0.4332	−0.4619	−51.60
LANGC	Language Competency	0.9801	0.7444	−0.2357	−24.05
ETHSI	Ethnic Similarity	0.5818	0.8826	0.3008	51.71
EMPEQ	Employment Equality	0.8685	0.5449	−0.3236	−37.26
INCEQ	Income Equality	0.5251	0.5569	0.0318	6.05
GISEQ	Gender Income Similarity	0.3064	0.5938	0.2874	93.81
RINCEQ	Racial Income Homogeneity	1.0000	0.0000	−1.0000	−100.00
LOGLK	Local Government Linkage	0.6260	0.5134	−0.1126	−17.98
STGLK	State Government Linkage	0.0263	0.0331	0.0068	25.66
FEDLK	Federal Government Linkage	0.0000	0.0000	0.0000	.

Appendix B.4. New York County (Manhattan), New York

Between 2010 and 2022, New York County, Manhattan, experienced modest population growth, increasing by approximately 11,200 residents (about 0.7%), a trend consistent with Census Bureau estimates indicating a slight 0.5% rise over the same period (USA Facts 2022f). Despite stable population levels, the county underwent substantial socioeconomic restructuring. Communication capacity improved (+16.5%), while indicators of social and economic equality showed notable gains: educational equality (+41.4%), employment equality (+21.1%), and income equality (+174%). Measures of gender income similarity (+1456%) and racial income homogeneity (+3227%) increased sharply, reflecting shifts in wage parity and the changing composition of Manhattan’s high-skill workforce associated with the borough’s roles in finance, technology, arts, and professional services.

At the same time, demographic change has been pronounced, particularly with respect to age. The share of residents under age 65 declined sharply in the index (−83%), consistent with Census Bureau findings showing rapid growth in the 65+ population (+36.2%) and declines in young adult groups. Ethnic similarity increased in the index (+342%), a pattern likely indicating changes in the internal distribution of major ethnic groups rather than decreasing diversity—as Census data confirm that New York County actually became *more* diverse between 2010 and 2022, with rising Asian and multiracial populations and shifting shares among Hispanic and non-Hispanic groups. Government linkage indicators, especially state linkage (+146%) and local linkage (+27%), also strengthened. Collectively, these changes portray a county characterized by strong institutional integration, rising socioeconomic equality, and an aging population amidst continuing demographic diversification—reflective of Manhattan’s position as a global center of economic activity, migration, and cultural dynamism.

Table A9. Changes in Social Capital Components in New York County, New York (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

New York County, New York		2010	2022	Absolute Change	Pct. Change
Population	Population	1,585,873	1,597,103	11,230	0.71
COMMC	Communication Capacity	0.8266	0.9633	0.1367	16.53
NONEL	Non-Elder Population (Share Under 65)	1.0000	0.1656	−0.8344	−83.44
EDUEQ	Educational Equality	0.5804	0.8209	0.2405	41.43
LANGC	Language Competency	0.5831	0.5816	−0.0015	−0.26
ETHSI	Ethnic Similarity	0.1741	0.7700	0.5959	342.31
EMPEQ	Employment Equality	0.5582	0.6760	0.1178	21.09
INCEQ	Income Equality	0.1005	0.2754	0.1750	174.16
GISEQ	Gender Income Similarity	0.0473	0.7355	0.6882	1455.92
RINCEQ	Racial Income Homogeneity	0.0291	0.9683	0.9392	3227.37
LOGLK	Local Government Linkage	0.1306	0.1658	0.0352	26.94
STGLK	State Government Linkage	0.0349	0.0857	0.0508	145.57
FEDLK	Federal Government Linkage	0.0594	0.0534	−0.0060	−10.16

Appendix B.5. Bronx County, New York

Bronx County, New York City’s northernmost borough, experienced a slight population decline between 2010 and 2022, decreasing from approximately 1,386,929 to 1,379,946 residents (−0.5%) (USA Facts 2022b). This trend stands in contrast to population growth in both the United States (+7.7%) and New York State (+1.4%) during the same period. Demographically, the borough underwent substantial restructuring: the 65+ population grew by 35.9%, while the 5–19 age cohort declined by 10.1%. Racial and ethnic shifts were also notable, with the Hispanic/Latino share increasing from 53.6% to 56.6% and the non-Hispanic White share declining from 11% to 8.7%. These dynamics—population stagnation, rapid aging, and intensified ethnoracial diversification—provide essential context for assessing movements in Bronx County’s Social Capital Index (SoCI).

Changes in the county’s normalized SoCI components between 2010 and 2022 were pronounced. Measures of demographic composition and social similarity increased sharply: ethnic similarity (ETHSI) rose from 0.0829 to 0.9836 (+1087%), and racial income homogeneity (RINCEQ) grew from 0.0107 to 0.9930 (+9143%), reflecting a shift from the lowest to among the highest relative similarity scores nationally. Gender income similarity (GISEQ) increased substantially (+543%), and income equality (INCEQ) and employment equality (EMPEQ) improved by approximately 24% each. Communication capacity also strengthened (+9.9%). In contrast, other indicators declined, including the non-elder population share (NONEL: −85%), language competency (LANGC: −13%), and educational equality (EDUEQ: −5%). Institutional linkage measures showed mixed trends: state linkage rose (+47.7%), whereas federal (−41%) and local (−13.6%) linkage declined. Together, these shifts indicate that demographic aging, ethnoracial concentration, and evolving economic and institutional conditions significantly reshaped Bronx County’s SoCI profile over the decade.

Table A10. Changes in Social Capital Components in Bronx County, New York (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

Bronx County, New York		2010	2022	Absolute Change	Pct. Change
Population	Population	1,385,108	1,384,189	−919	−0.07
COMMC	Communication Capacity	0.8343	0.9172	0.0829	9.94
NONEL	Non-Elder Population (Share Under 65)	1.0000	0.1452	−0.8547	−85.48
EDUEQ	Educational Equality	0.4654	0.4416	−0.0238	−5.11
LANGC	Language Competency	0.4168	0.3625	−0.0543	−13.03
ETHSI	Ethnic Similarity	0.0829	0.9836	0.9007	1086.71
EMPEQ	Employment Equality	0.3922	0.4850	0.0929	23.68
INCEQ	Income Equality	0.3721	0.4615	0.0893	24.01
GISEQ	Gender Income Similarity	0.1211	0.7788	0.6577	543.06
RINCEQ	Racial Income Homogeneity	0.0107	0.9930	0.9823	9142.67
LOGLK	Local Government Linkage	0.2814	0.2431	−0.0383	−13.61
STGLK	State Government Linkage	0.0506	0.0748	0.0241	47.67
FEDLK	Federal Government Linkage	0.0744	0.0439	−0.0305	−40.98

Appendix B.6. Falls Church City, Virginia

Falls Church City, Virginia, an independent, urbanized jurisdiction within the Washington, D.C., metropolitan area, experienced substantial demographic change between 2010 and 2022. The city’s population grew from 12,422 to 14,586 (+17.4%), outpacing both national (+7.7%) and statewide (+8.2%) growth (USA Facts 2022c). Growth occurred in 10 of 12 years, with the largest annual increase in 2016–2017 (+4.6%). Over the same period, the city became more racially and ethnically diverse: the Hispanic/Latino share rose from 9.4% to 11.6%, while the non-Hispanic White share fell from 73.6% to 69.4%. Age composition shifted as well, with the 65+ population growing by nearly 68%, while the proportion of young children declined slightly. These dynamics—population expansion, diversification, and demographic aging—establish the broader context for understanding longitudinal changes in the city’s Social Capital Index (SoCI) components.

Between 2010 and 2022, Falls Church City exhibited substantial increases across multiple normalized SoCI indicators. Educational equality (EDUEQ) increased from 0.6477 to 1.0000 (+54%), while gender income similarity (GISEQ) and racial income homogeneity (RINCEQ) grew dramatically (+684% and +671%, respectively), indicating pronounced gains in cross-group income parity. Employment equality (+17.8%), income equality (+20.8%), local government linkage (+41.8%), and state government linkage (+194%) also strengthened. Communication capacity rose modestly (+5.4%) and language competency remained stable (+1.6%). Conversely, several indicators declined: the non-elder population share (NONEL) dropped nearly to zero (−99.9%), reflecting the city’s rapid aging; ethnic similarity fell (−22%); and federal government linkage decreased (−26%). Taken together, these shifts show a micro-urban jurisdiction experiencing strong gains in socioeconomic equality and institutional integration, offset by demographic aging and moderate declines in ethnic similarity and federal linkage.

Table A11. Changes in Social Capital Components in Falls Church City, Virginia (2010–2022). All variables, except population, are normalized indicators ranging from 0 to 1. Values approaching 1 represent the highest relative level of the attribute among U.S. counties, while values approaching 0 represent the lowest. These scores reflect relative, not absolute, conditions, and caution is warranted—particularly for small counties—because minor demographic or economic shifts can generate large proportional changes in normalized metrics.

Fall Church City, Virginia		2010	2022	Absolute Change	Pct. Change
Population	Population	12,332	14,518	2186	17.73
COMMC	Communication Capacity	0.9440	0.9955	0.0515	5.45
NONEL	Non-Elder Population (Share Under 65)	0.9979	0.0015	−0.9965	−99.85
EDUEQ	Educational Equality	0.6477	1.0000	0.3523	54.40
LANGC	Language Competency	0.7678	0.7797	0.0119	1.55
ETHSI	Ethnic Similarity	0.5132	0.3994	−0.1138	−22.17
EMPEQ	Employment Equality	0.6586	0.7760	0.1174	17.83
INCEQ	Income Equality	0.5228	0.6314	0.1086	20.77
GISEQ	Gender Income Similarity	0.0845	0.6622	0.5777	683.50
RINCEQ	Racial Income Homogeneity	0.1088	0.8394	0.7306	671.20
LOGLK	Local Government Linkage	0.1521	0.2157	0.0636	41.83
STGLK	State Government Linkage	0.0227	0.0666	0.0440	193.86
FEDLK	Federal Government Linkage	0.8041	0.5911	−0.2130	−26.49

Appendix C. Calculations for Social Capital Measurements

Appendix C.1. Bonding Social Capital

Appendix C.1.1. Race Similarity

Race similarity is computed using a standard **fractionalization (homogeneity) index** following Alesina et al. (1999). The measure is constructed from the squared population shares of racial groups.

$$\text{Race Similarity} = 1 - \sum_{i=1}^n (\text{Race}_i)^2 \quad (\text{A1})$$

where:

- Race_i = proportion of population identifying with racial category i .
- $n = 7$ racial groups (White, Black, American Indian/Alaska Native, Asian, Pacific Islander, Other Race, Two or More Races).

$$\text{RACSI} = \frac{\text{RACSI}_p - \min(\text{RACSI}_p)}{\max(\text{RACSI}_p) - \min(\text{RACSI}_p)}$$

Appendix C.1.2. Ethnicity Similarity

Ethnicity similarity is computed using a two-group fractionalization index, comparing Hispanic and non-Hispanic population shares.

$$\text{Ethnic Similarity} = 1 - (\text{Hispanic}^2 + \text{NonHispanic}^2) \quad (\text{A2})$$

where:

- $\text{Hispanic} = \frac{\text{Hispanic population}}{\text{Total population}}$
- $\text{NonHispanic} = \frac{\text{Non-Hispanic population}}{\text{Total population}}$

$$\text{ETHSI} = \frac{\text{ETHSI}_p - \min(\text{ETHSI}_p)}{\max(\text{ETHSI}_p) - \min(\text{ETHSI}_p)}$$

Appendix C.1.3. Educational Equality

Educational equality compares the percentage of population with college education to the percentage with lower (high school or less) educational attainment.

First compute the proportions:

$$PCE = \frac{\text{Population with college or higher}}{\text{Total population}} \times 100$$

$$LHE = \frac{\text{Population with high school or less}}{\text{Total population}} \times 100$$

Then education equality is:

$$EE = (PCE - LHE) \quad (A3A)$$

To convert into a positive equality measure:

$$EE_R = 1 - EE \quad (A4B)$$

Normalized measure:

$$EDUEQ = \frac{EE_R - \min(EE_R)}{\max(EE_R) - \min(EE_R)}$$

Appendix C.1.4. Income Equality (From Gini Coefficient)

Income equality is derived from the Gini Index, where Gini measures inequality on [0,1] (or [0,100] in ACS).

$$II = \text{Gini}$$

$$IIR = 1 - II \quad (A4)$$

where:

- II = income inequality
- IIR = income equality

Normalized income equality:

$$INCEQ = \frac{IIR - \min(IIR)}{\max(IIR) - \min(IIR)}$$

Appendix C.1.5. Racial Income Equality

Racial income equality uses a **Herfindahl-type homogeneity index** computed from median household incomes of racial groups (A–G categories).

Let M_i be the median household income for racial group i .

Compute total across available non-missing groups:

$$T = \sum_{i \in S} M_i$$

where S = set of racial groups with non-missing medians.

Compute income share for each racial group:

$$s_i = \frac{M_i}{T}$$

Racial income equality is:

$$RINCEQ = 1 - \sum_{i \in S} s_i^2 \quad (A5)$$

Normalized form:

$$RINCEQ_{norm} = \frac{RINCEQ - \min(RINCEQ)}{\max(RINCEQ) - \min(RINCEQ)}$$

Appendix C.1.6. Employment Equality

Employment equality captures the balance between those employed and unemployed in the population aged 16 years and over.

$$PEMP = \frac{\text{Employed (16+)}}{\text{Population 16+}}$$

$$PUEMP = \frac{\text{Unemployed (16+)}}{\text{Population 16+}}$$

$$EE_R = PEMP - PUEMP$$

Interpretation:

Higher EE_R indicates relatively more employed individuals and thus greater employment equality.

Appendix C.1.7. Gender Income Similarity

Gender income similarity measures the similarity between male and female median nonfamily household incomes.

Let:

- MI = male median nonfamily household income
- FI = female median nonfamily household income
- TI = total median nonfamily household income

Income shares:

$$mi_{share} = \frac{MI}{TI}$$

$$fi_{share} = \frac{FI}{TI}$$

Gender income similarity:

$$GIS = 1 - (mi_{share}^2 + fi_{share}^2)$$

Higher GIS indicates greater equality between male and female household incomes.

Appendix C.1.8. Language Competency

Language competency reflects the proportion of the population aged 5+ that speaks only English at home.

$$LANGC_p = \frac{\text{English-only speakers}}{\text{Population age 5+}} \times 100$$

Higher values indicate greater English-language competency within the community.

Appendix C.1.9. Communication Capacity

Communication capacity measures telephone access in households.

Let:

- H_{TEL} = number of households with telephone service
- H_{TOT} = total households

$$COMMCP = \frac{H_{TEL}}{H_{TOT}} \times 100$$

Interpretation:

Higher values indicate better household communication infrastructure.

Appendix C.1.10. Non-Elder Population

This variable represents the percentage of the total population that is younger than 65.

Let:

- POP_{TOT} = total population
- POP_{65+} = population aged 65+

$$NONELP = \frac{POP_{TOT} - POP_{65+}}{POP_{TOT}} \times 100$$

Interpretation:

Higher values indicate a larger non-elderly population share.

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