Article

Not peer-reviewed version

Developing a conceptual framework for characterizing and measuring social resilience in blue-green infrastructure (BGI)

Angie Campbell , Victoria Chanse * , Mirjam Schindler

Posted Date: 12 March 2024

doi: 10.20944/preprints202403.0715.v1

Keywords: blue-green infrastructure; social resilience; urban sustainability

Article

Developing a Conceptual Framework for Characterizing and Measuring Social Resilience in Blue-Green Infrastructure (BGI)

Angela Campbell [1] and Victoria Chanse [2,*] Mirjam Schindler [3]

[1] School of Architecture and Design, Victoria University Wellington Te Herenga Waka, Wellington New Zealand; angie.campbell@vuw.ac.nz
[2] School of Architecture and Design, Victoria University Wellington Te Herenga Waka, Wellington New Zealand; victoria.chanse@vuw.ac.nz
[3] School of Geography, Environment, and Earth Sciences, Victoria University Wellington Te Herenga Waka, Wellington New Zealand; mirjam.schindler@vuw.ac.nz
* Correspondence: victoria.chanse@vuw.ac.nz

Abstract: Many cities are increasingly adopting blue-green infrastructure (BGI) to bolster resilience against environmental challenges. Beyond its well-acknowledged environmental benefits, the role of BGI in enhancing social resilience is becoming an equally important area of focus. However, the integration of BGI to foster social resilience presents complexities, stemming from the evolving and occasionally ambiguous definition of social resilience. Given its broad application across diverse disciplines, understanding and measuring social resilience proves difficult, posing challenges to understanding it within a BGI context. However, integrating BGI to support social resilience is complicated by the evolving and sometimes ambiguous definition of social resilience. This concept's broad applicability across various disciplines makes its understanding and measurement challenging, especially within the BGI context. Consequently, a clear need for a framework to effectively understand and measure social resilience in BGI settings exists. This paper synthesizes existing social resilience frameworks, particularly leveraging the comprehensive 5S framework by Saja et al. (2018), to create a new conceptual framework that addresses the unique social dimensions and benefits of BGI, incorporating insights from a broad literature review on social resilience. The framework is structured as a three-tier model centered around four key subdimensions of social resilience: social values, social capital, social structure, and social equity and their interrelationships. Characteristics and indicators are customized to support the BGI context integrating both physical and human dimensions within a mixed methods approach to measurement. Specifically, this research develops a conceptual BGI framework to probe into BGI practices and perspectives that enhance social resilience and considers demographic diversity and the spatial attributes of urban environments to understand how to foster more inclusive and socially resilient BGI spaces.

Keywords: blue-green infrastructure; social resilience; urban sustainability

1. Introduction

According to United Nations projections, two-thirds of the global population will reside in urban areas by 2050 (Population Division of the UN Department of Economic and Social Affairs, 2018). This rapid urban growth, coupled with suboptimal development practices, is escalating the community to various challenges associated with climate change, heightened disaster risk, and social fragmentation (Boyd et al., 2022; Minh Pham et al., 2020; Sachs et al., 2022). In response to these pressures, blue-green infrastructure (BGI) is increasingly recognized for its multifaceted benefits, encompassing environmental, social, cultural, and public health aspects (Foster et al., 2011; Kabisch et al., 2017; Millennium Ecosystem Assessment, 2005; Mukherjee & Takara, 2018; Scalenghe & Marson, 2009).While often implemented from the perspective of its stormwater regulating and climate mitigating benefit (Kabisch et al., 2017), BGI also plays a pivotal role in nurturing social connections within communities, which is essential to building social resilience (Mukherjee & Takara, 2018). The establishment of these

 doi:10.20944/preprints202403.0715.v1

social connections stands out as a paramount characteristic of a resilient community, with social resilience representing a pivotal component of a resilience profile (McMillan & Chavis, 1986).

BGI is an interconnected planned network of natural and semi-natural 'blue green' landscape components designed to deliver a wide range of ecosystem services at various scales (Ghofrani et al., 2017). From a social perspective, these spaces serve as communal hubs where people gather, interact, and engage in shared activities, enhancing social engagement and building social capital (Beatley & Newman, 2013; Campbell & Wisen, 2009). These regular interactions in BGI areas foster trust, solidarity, and a sense of belonging within the community. These social connections also have profound implications for mental health and emotional wellbeing (M. Francis et al., 1984).

BGI spaces often bring together diverse groups of people, facilitating exchanges that promote cultural understanding and tolerance (Svendsen & Campbell, 2006). Such interactions also address broader social issues like injustice, racism, exclusion, and inequity more effectively(Johnson et al., 2006; Vera & Speight, 2003). Moreover, these spaces advance social learning, information exchange, and problem-solving skills, enhancing a community's adaptive capacity and ability to respond to contemporary challenges (Altschuler & Somkin, 2004). Activities within these spaces strengthen and expand social networks and foster collaborative efforts. They provide opportunities for the community to share information and discuss, plan, and implement solutions to shared challenges.

Despite the recognition of the value of BGI spaces, there needs to be more clarity regarding the specific attributes and practices that effectively foster social resilience, while meeting the diverse needs of communities (Lo & Jim, 2012; Lopez et al., 2020). This lack of understanding is often attributed to the complexity and ambiguity of social resilience (S. Cutter, 2016; Saja et al., 2018) . As a result, a clear and concise framework that outlines key characteristics and indicators for measuring social resilience in BGI spaces is needed (Saja et al., 2018). However, this is challenging due to the complexity and ambiguity of the concept of social resilience (Saja et al., 2018).

Social resilience is studied and applied across many disciplines, and like many other interdisciplinary concepts, definitions of social resilience vary across the literature. Earlier, social resilience was defined as the ability or capacity of a social entity, such as an individual, community, or organization, to absorb, cope, and adjust to disturbances and threats because of social, political, and environmental change (Adger, 2000; Obrist et al., 2010). This definition focuses on the capacities of social entities to protect themselves from all kinds of hazards and threats.

As social resilience gained more prominence in the field of urban planning, it was referred to not only as a response to threats and disturbances or crisis planning but also as a means of strengthening social ties, improving wellbeing, and addressing inequities that may exist for vulnerable or marginalized groups (Leong & Malone-Lee, 2020). Studies highlight the importance of fostering trust and cooperation and understanding cultural practices and social norms, along with the capabilities to assimilate knowledge and learning within these frameworks, as essential for building and maintaining resilience (Campbell & Wisen, 2009; Feinberg et al., 2023; Gunderson, 2001). Today, social resilience is recognized as a critical component of sustainable urban development, particularly in fostering thriving and healthy communities (Dreiseitl & Wanshura, 2016; Surjono et al., 2021).

Early case study research on social resilience focused on various threats and stressors across temporal and spatial scales. These are broadly grouped in three categories 1) disaster management (S. Cutter et al., 2008; KI-Moon, 2010; Rose, 2004), 2) resource management and ecological urban resilience (Adger, 2000; Alberti et al., 2003; Barnett, 2001), and 3) social change and development referencing policy and institutional change (Adger, 2003; Pike et al., 2010). Across these categories are themes of learning, adaptation, and the recognition of political dynamics and processes (Keck & Sakdapolrak, 2013).

A diverse array of frameworks for assessing social resilience has emerged, each varying in its approach, focus, and breadth of characteristics and indicators it (S. Cutter, 2016; Saja et al., 2018). Many of these frameworks are rooted in disaster resilience literature, with a predominant emphasis on disaster risk, response, and management (S. Cutter, 2016; Kwok, 2016; Saja et al., 2018). Many of these frameworks focus on the role of social connections and relationships within the context of disaster

 doi:10.20944/preprints202403.0715.v1

preparedness, emphasizing their importance as support networks during emergencies or as channels for information and resource sharing post-crisis (Chandra et al., 2013; S. Cutter, 2016; Joerin et al., 2014). While this context is important, there's also a growing recognition of the broader potential of social dynamics in enhancing community health and well-being (Gardner, 2019; Jennings & Bamkole, 2019; O'Sullivan et al., 2021).

This expanded view encourages a comprehensive approach that includes strengthening community bonds, promoting well-being, and ensuring equity as key components of social resilience. Within this framing, BGI presents an ideal context for cultivating these relationships (Beatley & Newman, 2013; Hunter et al., 2019; Kwok, 2016; Mukherjee & Takara, 2018) and can be a tool for creating equity (Curran & Hamilton, 2012; Rigolon & Gibson, 2021), broadening the scope beyond disaster resilience to significantly contribute to the creation of resilient, healthy, and interconnected communities.

Acknowledging the insights from existing literature on the lack of a comprehensive framework for characterizing and measuring social resilience within disaster contexts, the challenge becomes even more pronounced when integrating BGI within a broader resilience framework. This gap limits the understanding of BGI's potential in strengthening social resilience, emphasizing a need for comprehensive approach extends beyond conventional scopes and delves into the nuanced interplay between BGI and social resilience in urban settings.

This manuscript presents a conceptual framework for characterizing and measuring social resilience within the context of BGI. It focuses on merging urban spatial features and BGI practices to foster social connections and promote equity. The development of this framework is grounded in a literature review of existing frameworks and an evaluation of two comprehensive social resilience frameworks, alongside a literature outlining the relationship of BGI and social resilience. The frameworks extend beyond the disaster-focused social resilience to encompass aspects of health and wellbeing in the community.

2. Applying Social Resilience Framework Concepts to BGI

The methodology for developing a conceptual framework for BGI entails a three-phase approach: (i) initially conducting a systematic review of academic literature on social resilience frameworks, (ii) followed by adapting framework elements specifically for BGI, and (iii) finally developing the structure and organization of a new conceptual framework. The literature review aims to understand the prevailing conceptual methods, metrics, and indicators and identify notable frameworks to inform the framework development. These are then critically examined, extracting relevant themes and concepts, and identifying gaps to address in the proposed framework. Key themes, characteristics, and indicators are analyzed for applicability in the BGI context. Lastly, these learnings are synthesized to present a comprehensive conceptualization and methodology for a new conceptual framework for the BGI context, called BGI Social Resilience Framework

2.1. Phase 1: Literature Review to Identify Social Resilience Frameworks

A systematic literature review was conducted to analyze social resilience frameworks critically. The literature selection captured a spectrum of social resilience approaches, integrating insights from disaster management and social change and development to facilitate a comprehensive analysis that acknowledges the multifaceted nature of social resilience beyond the traditionally emphasized disaster scenarios. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009) method was used to select resilience frameworks for detailed review. The PRISMA method is based on four steps: 1) identification, 2) screening, 3) eligibility, and 4) inclusion.

- Identification: An extensive search was conducted through Scopus and Google Scholar databases using the terms "Social" OR "Community" AND "Resilience", resulting in a large pool of literature, 25,000 Google Scholar and 62,209 Scopus, providing a vast base for initial consideration.

 doi:10.20944/preprints202403.0715.v1

- Screening – The literature review was refined by limiting to the subject areas most closely aligned to BGI and urban planning, such as social science, engineering, environmental science, and multidisciplinary studies, the English language, and journals relating to disaster, risk, and sustainable resilient cities and communities; 3356 articles were identified.
- Eligibility – The titles were screened to narrow the search for the most relevant articles. The title and abstracts of articles that do not relate to social or community resilience, disaster, or sustainability. 175 articles were identified.
- Inclusion – The abstracts of the 175 articles were reviewed, and 23 articles were selected, based on their inclusion of community, social, and/or disaster resilience in their title. From these articles, two were selected for detailed analysis. The first, proposed by Saja et al. (2018), is distinguished by its breadth, derived from the most comprehensive review of existing frameworks synthesizing themes. The second framework by Kwok et al. (2016), grounded in practitioner perspectives, notably incorporates subjective dimensions and normative indicators, distinguishing it from most existing frameworks They are summarized with critical learnings for application to the BGI context.

2.2. Phase 2: Adapting Social Resilience Characteristics and Indicators to the BGI Context

The second phase focused on identifying key social resilience characteristics and indicators from phase 1, particularly from Saja et al (2018) and Kwok et al., (2016) to develop a new framework for social resilience in the context of BGI. The analysis was organized by common dimensions for social resilience used in literature, social values, social capital, social structure, and social equity. These dimensions are also foundational in the Saja et al. (2018) framework. Characteristics that overlap between the frameworks suggested by Saja et al. (2018) and Kwok et al. (2016) were chosen and then tailored to the BGI context, with a strong emphasis on community-scale social dimensions. Additionally, the selection and adaptation of characteristics were intentionally steered towards a broader conceptualization of social resilience, emphasizing aspects of wellbeing and equity rather than focusing on disaster resilience specifically. Lastly, this phase paired adapted characteristics with suitable indicators crafted explicitly for the BGI context. The modification and selection process were primarily informed by literature on social resilience attributes realized in BGI, ensuring an alignment with BGI's role in enhancing community spaces.

2.3. Phase 3: Developing the BGI Social Resilience Framework

This phase brought together insights from Phases 1 and 2 to develop the BGI Social Resilience Framework using the organizational structure 5S framework by Saja et al. (2018) To address identified gaps in the literature concerning the lack of methodological tools (Saja et al., 2019), an additional fourth tier was introduced and relationships between social resilience dimension were identified from the literature to offer specific guidance on measurement tools and techniques essential for operationalizing the framework.

3. Results

3.1. Challenges and Complexities in Defining and Operationalizing Social Resilience across Disciplines

The concept of resilience has evolved significantly, cutting across multiple research fields and introducing complexity and ambiguity. Each discipline contributes its unique definition and conceptualization, creating notable inconsistencies in data collection and measurement methodologies (Norris et al., 2008). This variability challenges operationalizing resilience into practical applications (Urquiza et al., 2021). Particularly in social-ecological resilience, these challenges are compounded by the concept's abstract and process and outcome-oriented nature involving interrelated properties within complex and dynamic social systems (Saja et al., 2018). These systems are also spatially and temporally bound, meaning that the levels of social resilience change throughout a disturbance cycle (Paton, 2006) and are highly influenced by place and community (Cox & Perry, 2011; Kwok, 2016). Further complicating resilience applications, there is a lack of clarity in the literature regarding what characteristics to measure, which indicators to use, and for what purpose

 doi:10.20944/preprints202403.0715.v1

and context (Saja et al., 2018) and how they intertwine, in practice, with other climate-related concepts like risk, vulnerability, adaptation, planning, and sustainability (Elmqvist et al., 2019; Leichenko, 2011).

This phenomenon is evident in the urban planning realm, where several frameworks assess social resilience within the disaster and natural hazards context (Aldrich, 2010; S. Cutter et al., 2008; Pelling & High, 2005; Saja et al., 2019). These frameworks exhibit diversity in their approach to understanding social resilience, utilizing a multitude of subdimensions, characteristics, and indicators (Saja et al., 2018). There is also variability in the conceptualization and methodological approaches (Saja et al., 2019).

While the sub-dimensions within social resilience frameworks have a degree of consistency, the range of characteristics and indicators is quite broad (Saja et al., 2018; Sharifi, 2016). Saja et al. (2018) analyzed 31 existing frameworks and identified 80 unique characteristics and indicators related to social resilience, yet no single predominant concept for framework development emerged. Furthermore, an extensive review by Cutter et al. (2016) of 27 different resilience tools, indices, and scorecards revealed the absence of a dominant approach in selecting characteristics.

3.1.1. Conceptualization and Context

The lack of clarity and consistency on how social resilience is defined has resulted in confusion about how key concepts are understood, interpreted, and applied. The basic framework for adapting to a particular resilience concept has no uniform approach (Saja et al., 2019), leading to diverse conceptualizations. These can range from focusing on various types of capital to emphasizing singular dimensional attributes or considering different stages within a resilience cycle to establishing unique, stand-alone frameworks encompassing numerous key characteristics of social resilience (S. Cutter, 2016; Saja et al., 2019). Such conceptual variations significantly impact the metrics and methods of measurement, complicating the ability to compare findings across different research efforts (S. Cutter, 2016; Sharifi, 2016).

Saja et al (2019) outlines the following social capital conceptualizations. These are graphically illustrated in Figure 1.

- Capital based – emphasis on social capital with different types of social assets that can be attributed to key social resilience characteristics.
- Coping, adaptive, transformative (CAT) capacities – captures dynamic attributes of social systems on multiple scales.
- Social & interconnected community resilience – social resilience within a holistic, multidimensional characteristic of community resilience.
- Structural & cognitive dimensions – discrete features of a social entity, people, and communities (structural) and attitudes, values, beliefs, and perceptions (cognitive).

Further complicating the landscape are the distinguishing properties such as a scalar unit of analysis, geographic context, and hazard type, each introducing distinct attributes and measurement challenges (S. Cutter, 2016; Saja et al., 2019). Considering the scale, the household level, the focus tends to be on financial stability and access to essential resources and access to social safety nets (Jones & Tanner, 2017) while community resilience emphasizes cohesion and diverse value systems (Aldrich, 2010; Aldrich & Meyer, 2014; Putnam, 2000). City-scale resilience prioritizes infrastructure and the built environment's disaster readiness (Dreiseitl & Wanshura, 2016; Kabisch et al., 2017; Meerow, 2020; Pamukcu-Albers et al., 2021), whereas global resilience considerations span broader environmental impacts such large food systems, biodiversity, and disease (Abbass et al., 2022).

In comparing urban and rural contexts, the underlying factors of resilience diverge. Urban resilience tends to rely on economic capital, while in rural areas, the key to disaster resilience lies within community capital (S. Cutter, 2016; Saja et al., 2019). Lastly, the specific nature of hazards, from gradual threats like rising sea levels to immediate crises like earthquakes, necessitates tailored resilience strategies. This variability across different scales and contexts highlights the complexity of developing a unified approach to measuring social resilience, emphasizing the need for flexibility and specificity in resilience planning and measurement.

 doi:10.20944/preprints202403.0715.v1

Figure 1. Four types of social resilience conceptualizations adapted from (Saja et al., 2019).

3.1.2. Methodology & Indicators

The ambiguity and process orientation dimension inherent in the concept of social resilience presents challenges in its quantification and measurement (S. Cutter, 2016; Saja et al., 2018). This lack of clarity has resulted in variability in methodology types and uncertainties about what should be measured (S. Cutter, 2016; Saja et al., 2018). Furthermore, current frameworks are critiqued for not adequately capturing the dynamic, transformative, and recovery aspects of resilience (Copeland et al., 2020; Saja et al., 2018) and for overlooking the normative implications in defining communities and their attributes as indicators (Copeland et al., 2020).

According to systemic reviews of social resilience frameworks, the most common measurement strategy uses characteristics with corresponding indicators (Copeland et al., 2020; S. Cutter, 2016; Saja et al., 2018). The indicator method is also the preferred approach of agencies and practitioners (Saja et al., 2018). Other methods include scorecards, an aggregate of scores indicating how often the items is present and scorecards that guide through sample procedures, survey instruments, or data for use (S. Cutter, 2016).

When examining the character-indicator method, these challenges are further exacerbated by the limited guidance regarding the appropriate characteristics and indicators to use within a specific purpose or context (S. Cutter, 2016). It is essential to distinguish between characteristics and indicators.

 doi:10.20944/preprints202403.0715.v1

Characteristics help characterize an ideal state of resilience in general terms (Twigg, 2015). while an indicator describes measurable information used to identify a social entity's state or function (Saja et al., 2019).An indicator or set of indicators measures a resilience characteristic (Saja et al., 2019). Resilience indicators are instrumental in defining the fundamental components of the system or entity under study and help facilitate increased community awareness (Prior & Hagmann, 2014). Additionally, they are crucial in guiding communities in evaluating and prioritizing their needs and objectives (S. Cutter, 2016).

To measure social resilience effectively, three types of indicators are commonly utilized: outcome, process indicators, and normative (S. Cutter, 2016; Saja et al., 2018, 2019). Each type of indicator serves a distinct purpose, with their differentiation elaborated upon below.

- Outcome indicators capture the static results or how well processes, interventions, or programs accomplish a proposed result. They represent the final or observable outcomes to achieve or measure. Outcomes include faster recovery time, improved well-being, community cohesion, disaster preparedness, and risk reduction (S. Cutter, 2016; Saja et al., 2018, 2019).
- Process – Process indicators typically capture dynamic and ongoing aspects of a phenomenon. They focus on the activities, behaviors, or steps involved in a process, intervention, or program. They are valuable for assessing whether participants actively engage with and respond to an intervention. Examples may include the level of engagement, the frequency of communication, and a feeling of belonging to a community (S. Cutter, 2016; Saja et al., 2018, 2019).
- Normative - shared beliefs, principles, and standards that guide the behavior of interactions of individuals in a community (Saja et al., 2019).

Many social resilience frameworks focus on static outcome indicators rather than process-related ones because they are more accessible and relatively easy to measure (Saja et al., 2018, 2019). However, understanding social resilience requires a broader lens that includes process-related indicators, such as community competence, information dissemination, and community participation, which are vital but more complex to quantify (Norris et al., 2008). Additionally, normative indicators play a pivotal role in capturing a community's unique character and context, reflecting local values and priorities that define what is essential to its members (Saja et al., 2019).

To navigate these complexities effectively, refining resilience frameworks to include a balance of outcome, process, and normative indicators, each offering valuable insights into different facets of social resilience, is essential. Such a comprehensive approach will provide a more accurate and actionable understanding of resilience, enabling communities to develop targeted strategies for enhancing their collective strength and adaptability.

3.1.3. Summary

Table 1 comprehensively summarizes the conceptual and methodological spectrum discussed in previous sections. The spectrum of dimensions is categorized, described, and linked to specific frameworks that utilize each concept. This table synthesizes the field's heterogeneity, demonstrating the range of existing analytical methods while tracing their usage in an established resilience framework.

Table 1. Conceptual and methodological spectrum of social resilience frameworks.

Dimension		Description	Framework References
Conceptualization	Structural & cognitive	Encompasses (structural) discrete features and characteristics of a social entity and (cognitive) attitudes, values, and beliefs	(Kwok, 2016; Saja et al., 2018)
	Coping, adaptive, transformation	Capacities of communities to cope adapt, and transform to dynamic challenges; embracing change, and fostering long-term sustainability and growth.	(Lyon, 2014; Parsons et al., 2016)

 doi:10.20944/preprints202403.0715.v1

	Social & interconnected	Web of relationships & networks within a community, underscoring the role of social ties, collective action, and the integration of diverse community Resources in building resilience.	(S. Cutter et al., 2008; Saja et al., 2018; Sempier et al., 2010)
	Capital based	resilience in terms of capital and strategic deployment of resources as essential	(S. L. Cutter & Derakhshan, 2021; Mayunga, 2007; Yoon et al., 2016)
Context	Hazard specific	e.g. earthquake, flood, drought, sea level rise	(Burton, 2015; Jurjonas & Seekamp, 2018)
	Geographical context	urban, coastal, rural, city, mountains, islands	(Chandra et al., 2013; Imperiale & Vanclay, 2016; Jurjonas & Seekamp, 2018; Ribeiro & Goncalves, 2019)
	Hierarchical scale	Individual, community, governmental	(B. Pfefferbaum et al., 2017; Saja et al., 2019)
Assessment type	Indicator	Observable measurable characteristic/change representing resilience characteristic	(Burton, 2015; Kwok, 2016; Mayunga, 2007; Saja et al., 2018; Sharifi & Yamagata, 2016; Yoon et al., 2016)
	Scorecard	Aggregate of score based on how often the items are present, often providing evaluation of progress to goal.	(Berke et al., 2015; Ramsey et al., 2016)
	Toolkit	Guidance through sample procedures, survey ins(R. L. Pfefferbaum et al., 2013; Schoch-Spana et al., 2019)	(Arbon, 2014; R. L. Pfefferbaum et al., 2013; Schoch-Spana et al., 2019)
Indicator type	Outcome	How well interventions accomplish a result	(Burton, 2015; S. Cutter, 2016; Kwok, 2016; Saja et al., 2019; Sharifi & Yamagata, 2016)
	Process	Level of engagement in phenomenon	(Burton, 2015; S. Cutter, 2016; Kwok, 2016; Saja et al., 2019; Sharifi &

 doi:10.20944/preprints202403.0715.v1

		Yamagata, 2016)
Normative	Shared beliefs & values guiding behaviour	(Copeland et al., 2020; Kwok, 2016)

3.2. Key Resilience Frameworks

The literature review notably identifies two frameworks as significant reference points for developing a BGI-specific framework. These frameworks are: 'An inclusive and adaptive framework for measuring social resilience to disasters (Saja et al., 2018) and 'What is 'social resilience'? Perspectives of disaster researchers, emergency management practitioners, and policymakers in Aotearoa New Zealand disasters' (Kwok, 2016). These will be referred to as the 5S framework and the practitioner framework, respectively, in subsequent discussions.

The 5S framework, the most comprehensive review of social resilience frameworks, is intended as a flexible template for future applications(Saja et al., 2018). This framework is foundational for creating a conceptual framework for its comprehensive nature, organizational structure, and inclusion of prevalent themes from existing frameworks. The practitioner framework is distinguished by its bottom-up, community-place-based methodology, utilizing interviews to derive subjective insights, a technique less common in framework development (Kwok, 2016). Its focus on context and conceptualization supports a mixed methods approach that provides a valuable perspective for subsequent research and framework development of the BGI Social Resilience Framework.

3.2.1. Inclusive & Adaptive 5S Framework

The development of the 5S framework is based on a critical review of existing social resilience frameworks which identified inconsistencies in how social resilience is understood. Through a comprehensive review of 31 existing frameworks, the aim was to standardize the benchmarking and synthesis key social resilience characteristics and indicators to create a versatile model that could be applied in diverse contexts. To structure the 5S framework effectively, a matrix was constructed from identified characteristics and indicators of these frameworks, re-clustering the characteristics to pinpoint commonalities and then assigning the most frequently used indicators for each characteristic. Lastly, the characteristics were thematically clustered to generate the five sub-dimensions that form the frameworks' structure. Each layer in the framework builds upon the previous, creating a cohesive and interconnected structure. This sequential layering is depicted in the process and the resulting three-layer framework is illustrated in Figure 2.

 doi:10.20944/preprints202403.0715.v1

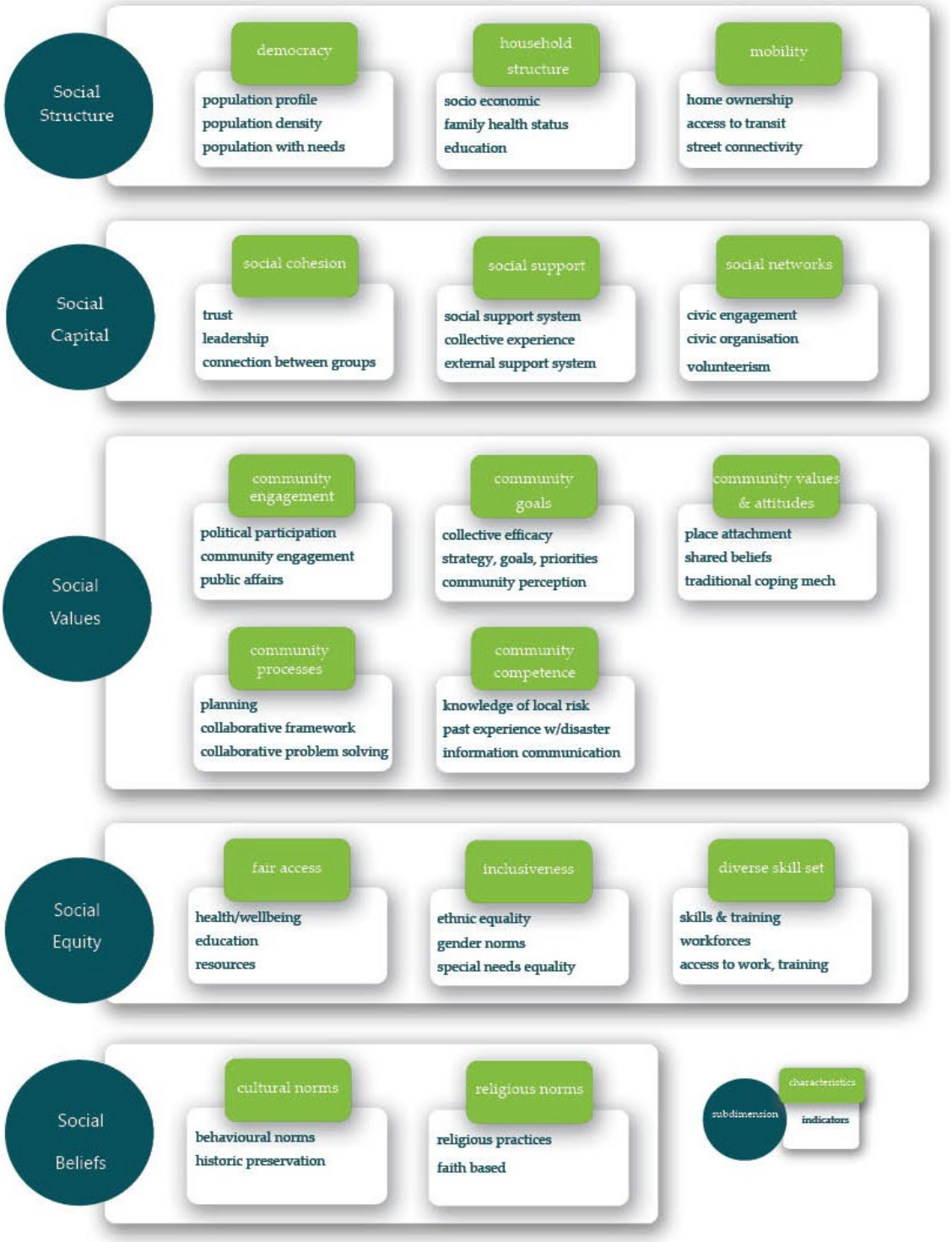

Figure 2. An inclusive and adaptive '5S' social resilience framework adapted from (Saja et al., 2018).

The 5S framework provides key learnings for developing a BGI-specific framework by addressing the challenges of measuring social resilience through a structured and evidence-based approach (Saja et al., 2018). Its strengths lie in the methodological rigor that identifies common themes and concepts pivotal for social resilience, integrating a balanced mix of outcome, process, and normative indicators. Particularly noteworthy is its inclusion of process indicators, which focus on actions and mechanisms for fostering resilience, and normative indicators, which guide human behavior, elements often neglected in other frameworks (Copeland et al., 2020). The 5S framework's

 doi:10.20944/preprints202403.0715.v1

organization around widely recognized subdimensions of social resilience creates a clear, tiered structure, making it an effective tool for capturing the transformative and recovery aspects of resilience. This includes facets such as volunteerism, community engagement strategies, and information and communication channels, which are essential for inclusive engagement and capacity building within communities (Broeder et al., 2022; Campbell & Wisen, 2009; Miller, 2020).

However, the application of the 5S framework reveals limitations that need addressing to enhance its practicality in a BGI context. Its complexity and the broad spectrum of indicators necessitate a focused refinement to better suit the non-disaster specific aspects of social resilience, such as strengthening social connections and addressing well-being and equity concerns. The framework's scale variability also indicates the need for a more singular focus that resonates with community-level interactions, especially for BGI. Furthermore, the absence of detailed guidance on measurement tools underscores the importance of contextualizing indicators to account for spatial relationships and community values. By considering these adjustments and incorporating direct community input, the BGI Social Resilience Framework can avoid potential disconnects between theoretical constructs and the lived experiences of communities, ensuring a more grounded and responsive approach to building social resilience through BGI.

3.2.2. Practitioner Perspectives from Aotearoa New Zealand

Research by Kwok et al. (2016) seeks to capture the nuances of social resilience from the community perspective. Conducted through workshops in Aotearoa New Zealand, it utilized group interviews to explore the participants' views on social resilience, identify key contributing elements, and pinpoint initiatives for enhancing community resilience. The study led to the identification of 66 social resilience attributes, with particular emphasis on the significance of place, relationships, learning, and governance. These attributes, reflecting both cognitive and structural dimensions, span across human capital, economic resilience, the built environment, and governance, and are considered essential for strengthening community resilience. The outcomes of this research have been synthesized into a set of core attributes and actionable strategies, offering a robust framework for agencies to support resilience-building efforts within communities. The core attributes of social resilience of communities and accompanying resilience-enhancing actions are outlined in the framework in Figure 3: Core attributes of social resilience of communities (Kwok, 2016).

The practitioner framework, through its blend of interview insights and literature review, offers a compelling approach for integrating human-centric considerations into the understanding of social resilience at a community level. It stands out for its structural and cognitive categorization of attributes, which clarifies the distinction between the tangible aspects of resilience and the underlying cultural or behavioral dynamics. This framework is particularly valuable for its place-based focus, capturing the intricacies of local dynamics through a bottom-up approach that reveals the normative and perceptual components essential for resilience. These insights are crucial for BGI framework development, emphasizing the role of natural environments and community spaces as pivotal in fostering social ties and resilience.

 doi:10.20944/preprints202403.0715.v1

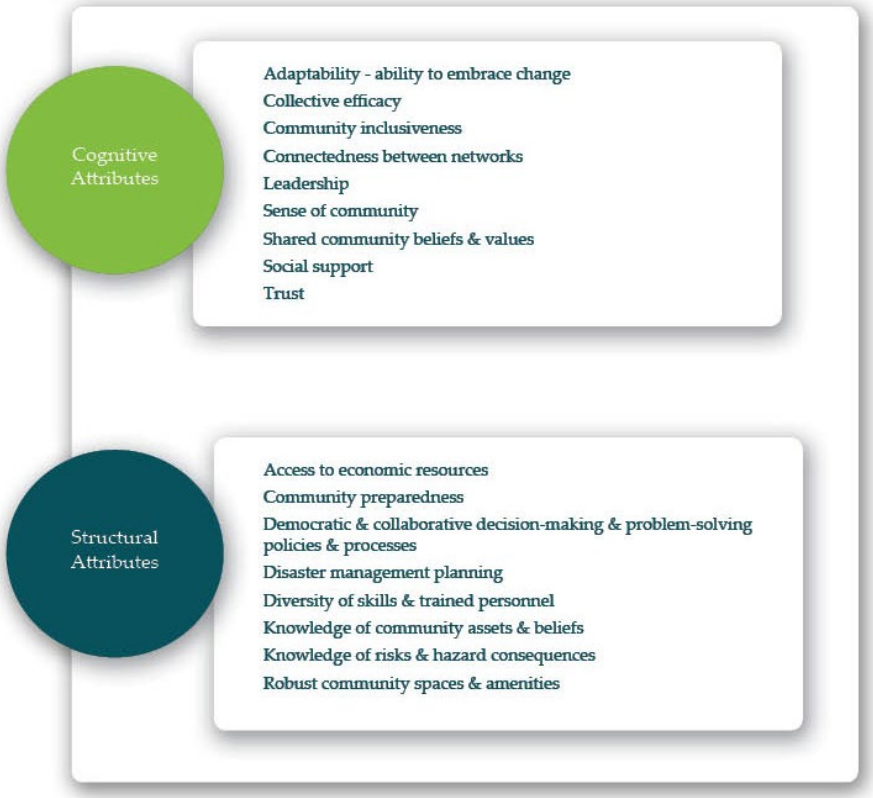

Figure 3. Core attributes of social resilience of communities adapted from (Kwok, 2016).

However, while the practitioner framework excels in theoretical organization, it encounters practical challenges, notably the absence of direct community engagement in its development process. This gap suggests a potential disconnect between the framework's structure and the lived realities of the communities it seeks to serve. Despite these limitations, the framework's emphasis on actionable items and its recognition of greenspaces and community gatherings as essential for building social resilience provide a strong foundation for BGI considerations. By incorporating these elements, the BGI Social Resilience Framework can more effectively capture both the physical infrastructure and the social cohesion necessary for resilient communities, aiming to strike a balance between comprehensive planning and the adaptability required for diverse urban settings.

3.3. Selection of Characteristics & Indicators for the BGI Context

Leveraging the organizational structure of the 5S framework, the BGI Social Resilience Framework is designed following a similar three-tiered approach, encompassing sub-dimensions, characteristics, and indicators, all specifically adapted to the BGI context. It retains the four critical dimensions of social resilience; social values & beliefs, social capital, social structure, and social characteristics. The selection of characteristics and corresponding indicators is informed by the interrelationships between these dimensions and the broader BGI literature. Characteristics shared between 5S framework and practitioner models that are particularly pertinent to community-scale social dimensions of BGI, have further shaped this guidance. Detailed examinations of each selected characteristic, the customized indicators are presented in the subsequent sections.

3.3.1. Social values & beliefs

Local culture, social beliefs, and shared values play a significant role in determining social resilience (Kwok, 2016). These elements are not just abstract concepts but have a tangible impact on how communities forge strong social networks, adapt to challenges, and enhance their resilience

 doi:10.20944/preprints202403.0715.v1

(Adger et al., 2013; Campbell & Wisen, 2009; Shiva, 2006). Furthermore, these shared values and beliefs are instrumental in guiding collective actions and influencing the community's preferences towards various resilience strategies (Saja et al., 2018).

Social values in this context consist of two types of values: 1) held values – ideas or principles that people hold as important to them and 2) assigned values - values that individuals attach to physical places (Lockwood, 2005; Seymour et al., 2010). Generally, held values are broader and refer to ethical, moral, or ideological values, while assigned values are specific to place and may include aesthetic, therapeutic, and cultural values (van Riper et al., 2016) Unlike held values, assigned values are not absolute because they are influenced by context and the perceptions and preferences of an individual (Brown, 1979; Seymour et al., 2010). These values are oriented by beliefs or ideologies and influence an individual's attitude and behavior, with context further influencing perceptions (Vaske & Donnelly, 1999). Together these subjective dimensions (values and beliefs) provide a lens through which people perceive the world and enrich our understanding of human processes, behavior, and preferences (Armitage et al., 2012; White et al., 2013).

In the domain of BGI, the subjective dimensions such as, users' sense of safety, satisfaction with spaces, perceptions of sociability and quality, as well as preferences towards activity, aesthetics, and size serve as a cornerstone for its efficacy (Ode Sang et al., 2016; Samsudin et al., 2022). These dimensions affect how and whether people engage with these spaces (Lee & Kim, 2015; Schindler et al., 2018) and the degree for which this engagement translates to community interactions (Gobster & Westphal, 2004; Moseley et al., 2013). They are a stronger predictor for frequency of visits (Fongar et al., 2019), development of social networks (Samsudin et al., 2022), and whether users engage in activities (Fongar et al., 2019), compared to objective dimensions.

Given that these dimensions are influenced by personal experiences and cultural ideologies, they exhibit variability across demographic groups (Dade et al., 2020; Phillips et al., 2021; Schindler et al., 2018). Research on greenspace engagement provides valuable insights into the diverse preferences and levels of engagement among different demographic groups, emphasizing the crucial role of demographics in understanding individuals' interactions with spaces (Gehl, 2013). Examples of preference variability include women and passive use, older adults and nature-based activities and younger people and social uses (Lo & Jim, 2012; Wen et al., 2018). Women (Williams et al., 2020), youth of color (Rigolon, 2017), and people with disabilities have more significant concerns around safety (Wong et al., 2023) and these concerns can often discourage their use of spaces.

This intersection of perception and practice that captures a wide array of user experiences, attitudes, and actions with BGI is important to understand. It not only dictates the level of interaction between community members and BGI, but also reflects the subjective lens through which these spaces are valued and utilized. By highlighting how individual and collective values and beliefs influence engagement with BGI makes a compelling case for the integration of perception and practice as characteristics in BGI planning and management.

To effectively gauge perceptions and practice within a BGI context the chosen indicators include 'valued attributes' for perception, alongside 'activities/use' and 'information sharing' for practices. These indicators, encompassing both normative values and procedural elements, are instrumental in assessing the social acceptance of BGI and yield valuable perspectives on its utilization, management, community interactions and information sharing. Perception is both quantitative (e.g., size, greenery) and qualitative (e.g., aesthetics, sociability, quality, and usage) (Samsudin et al., 2022). Practices encompass a range of activities such as walking/jogging, sports, community gardening, restoration, socializing, and participating in community events, common activities in BGI (Lamond & Evertt, 2019).

Alongside activities, communication and information sharing emerge as a distinct practice within BGI, reflecting the nuanced ways communities interact with and value their green spaces (Saja et al., 2018). Communication and information sharing are often featured as an important component in disaster resilience frameworks (Alsheri et al., 2015; Norris et al., 2008; Saja et al., 2018) as improved communication and awareness improve the effectiveness of disaster response (Adger, 2003; Saja et al., 2018)This practice is also a reflection of a community's values regarding engagement, stewardship,

 doi:10.20944/preprints202403.0715.v1

and mutual support (Campbell & Wisen, 2009) and can better enable engagement, learning, and translate human values into action through stewardship (Ingram & Hamilton, 2014), which all contribute to improving resilience (Tidball et al., 2010).

Capturing these subjective dimensions is crucial not only for the development of functional physical BGI spaces but also for creating environments that align with the cultural and social fabric of the community, thus fostering a resilient and actively engaged community. A graphic illustration summarizing the characteristics and indicators associated with the social values & beliefs dimension is shown in Figure 4.

Figure 4. Social values & beliefs characteristics and indicators.

3.3.2. Social Capital

Social capital is a key dimension of social resilience and is widely recognized and studied for its highly influential role (Adger, 2003; Aldrich & Meyer, 2014; Saja et al., 2018). Social capital refers to the relational networks and trust that exist between individuals and groups of people and the benefits that can be derived from those connections (Putnam, 1993) It encompasses a network of social connections, spanning across individuals and groups, that confer a multitude of invaluable benefits through reciprocity (Putnam, 1993). It holds intangible aspects of trust, norms, and values, as well as tangible resource and connections within social networks (Hyyppä, 2010).

Several studies reveal that communities with high social capital adapt, cope, and recover better following a disturbance (Adger, 2000; Chamlee-Wright & Storr, 2009; Hawkins & Maurer, 2011; Nakagawa & Shaw, 2004). Outside of the disaster context, social capital plays a vital role in building cohesive, healthy, and tolerant communities. Fostering community cohesion and trust and can help cultivate relationships across diverse communities (Svendsen, 2009) helping bridge social divides, enhance cultural competency Stewardship, learning, and memory in disaster resilience and mitigate social fragmentation (Fagg et al., 2008; Minh Pham et al., 2020). Social networks established through relationships have profound implications for mental health and emotional well-being. Socially connected communities share a sense of belonging, which is associated to a greater sense of purpose, identity, and emotional well-being (J. Francis et al., 2012). Communities with high social capital often report lower levels of psychological distress and improved coping strategies (Matthews et al., 2020).

BGI spaces are key environments where individuals come together, fostering connections, and engaging in activities that strengthen social networks and contribute to the development of social capital (Beatley & Newman, 2013; Campbell & Wisen, 2009). They function as crucial hubs for social gatherings and a variety of activities that enhance a community's resilience (Foster et al., 2015). Through these collective experiences and engagements, BGI spaces facilitate the formation of social networks and the establishment of trust among community members (Jennings & Bamkole, 2019). In the realm of BGI, social capital extends beyond the mere formation of social networks to how these networks are leveraged for mutual benefit. BGI spaces are instrumental in knitting the community's social fabric more closely, ensuring it remains vibrant and adaptable to the needs of its members. Thus, the fundamental characteristics of social capital within this context are identified as connections

 doi:10.20944/preprints202403.0715.v1

and engagement, reflecting the integral role BGI spaces play in cultivating community ties and active involvement.

Given this, it becomes necessary to ascertain which indicators are most salient at the community level within the BGI context and subsequently elucidate the defining characteristics of each. Reflecting on a foundational definition by Putnam (1993) which encompasses 'relational networks and trust,' along with the 'benefits accruing from such connections,' notably social cohesion, a distinct correlation emerges within the BGI contexts. Herein, the genesis of these relational networks is intrinsically linked to participatory dynamics and a shared sense of place efficacy (Campbell & Wisen, 2009). Consequently, the chosen indicators include 'networks, trust, and reciprocity, for connections, alongside 'participation' and 'social cohesion' for engagement. These serve as indicators in various studies (Berry & Welsh, 2010; Samsudin et al., 2022; Maseda et al., 2012) and are integral to renowned tools for measuring social capital, such as the World Bank SC-IQ, Social Capital Community Benchmark Survey (SCCBS), European Social Survey (ESS), and the Australian Bureau of Statistics (ABS) Social Capital Framework.

Networks, trust, and reciprocity serve as foundational indicators of social connections within communities, illustrating the depth and quality of interpersonal relationships that form the backbone of social capital (Putnam, 2000). Social networks are defined by the strength, diversity, frequency, and duration of connections within a social system (Marin & Wellman, 2011). Trust serves as the foundation for enabling cooperative action and while reciprocity emerges as the mutual exchange of support and assistance among community members, with both aspects being mutually reinforcing (Saja et al., 2018).

Participation and social cohesion are critical indicators of community engagement, highlighting the active involvement and unity within communities. Participation illustrates the degree to which individuals contribute to and involve themselves in community activities, reflecting their commitment to communal goals and the BGI spaces that facilitate such interactions (Campbell & Wisen, 2009; World Health Organization, 2017). Social cohesion is a multifaceted concept that is used to characterize the social environment (Jennings & Bamkole, 2019) often referring to the degree of social connectedness and solidarity (Jewett et al., 2021). Social cohesion relates to positive social interactions(Jennings & Bamkole, 2019), and can invite a sense of belonging (Forrest & Kearns, 2001) and community and level of cooperation within a community (Schiefer & van der Noll, 2017).

Reflecting on these definitions, the indicators are organized based on their fundamental characteristics into two categories: 1) Connections, which include networks, trust, and reciprocity, and 2) Engagement, encompassing social cohesion and participation. A graphic illustration summarizing the characteristics and indicators associated with the social capital dimension is shown in Figure 5.

Figure 5. Social capital characteristics and indicators.

3.3.3. Social Structure

Social structure is broadly defined to refer to top networks, relationships, and population composition and distribution (Nadel, 2013). Within the 5S framework, social structure is defined as the distribution and composition of a population within a geographic space with parameters such as

 doi:10.20944/preprints202403.0715.v1

age, gender, cultural backgrounds, and socio economics (Saja et al., 2018). It includes aspects like demographics and socio-economic stratification and the diverse functions people fulfil within a community, including education, recreation, social interactions, and mobility. This definition provides the basis for place-based and contextual analysis, offering insights about the individuals residing in and engaging with a specific area. It facilitates the creation of a vision informed by demographic realities and ensures that the unique needs of the served population are adequately addressed (Cecchini et al., 2019). In the field of resilience, factors such as population growth, increasing inequality, human mobility, and development in areas prone to hazards are recognized as critical elements impacting resilience (Adger, 2000; Aldrich & Meyer, 2015; S. Cutter et al., 2014; Guadagno, 2016). Within this context, the social structure components of demographics and mobility are pivotal, especially concerning the challenges posed by urbanization and climate change. These challenges disproportionately affect socially vulnerable groups, including those with lower income, dependent children, older adults, and individuals with disabilities, underscoring a regressive impact (Boyd et al., 2022; Sachs et al., 2022). Moreover, individuals with greater mobility, whether socio-economic or physical, exhibit enhanced resilience, particularly in disaster evacuation and recovery scenarios (Saja et al., 2018).

Within the 5S framework, key characteristics underpinning resilience include social demographics, household structure, and mobility (Saja et al., 2018). Social demographics encompasses the spatial composition, density, and profile of the population, focusing on specific community needs (Saja et al., 2018). Household structure delves into the micro-level aspects of a community, examining socio-economic factors like income, education, and health status (Saja et al., 2018). Mobility encompasses both long-term aspects such as home ownership and migration, and short-term elements like accessibility to transportation and street connectivity (Saja et al., 2018).

In the BGI context, understanding social structure is key to identifying the makeup of communities and promoting equitable access tailored to the specific requirements of various demographic segments, particularly in terms of mobility. Groups like older adults, women, children, and individuals with disabilities, who face heightened safety and accessibility challenges, are notably more vulnerable to adverse health outcomes (Krahn et al., 2015; Louv, 2005; Roe et al., 2013) Consequently, the United Nations' Sustainable Development Goal 11.7 underscores the importance of establishing green spaces that are safe, inclusive, and accessible, aiming to counteract the disparities in greenspace access experienced by these vulnerable populations (United Nations, Department of Economic and Social Affairs, Population Division, 2022).

Demographic insights are pivotal in shaping BGI spaces to ensure they are accessible and inclusive for all community members. Such characteristics not only reveal who actively engages with BGI but also facilitate a spatial analysis to thoroughly evaluate accessibility. This evaluation is critical, as mobility, especially in terms of walkability influences the likelihood and frequency of BGI usage (Forsyth, 2015). Social resilience in BGI areas depends on regular community participation to fully achieve all resilience benefits. By weaving demographic data and mobility considerations into the fabric of BGI planning, it's possible to tailor these green spaces to the nuanced needs of the community.

Indicators of demographics and walkability need to capture the spatial composition and functionality of physical space to align with the broader goals of social structure and resiliency. Demographics indicators include typical population profile data and their geographic location, ensuring that vulnerable communities with specific needs such as lower-income groups, families with dependent children, older adults, women, and people with disabilities (Boyd et al., 2022; Sachs et al., 2022) are represented. Walkability indicators, such as walking scores, offer a quantitative measure of an area's pedestrian-friendliness, incorporating factors like the availability of foot infrastructure, the influence of topography, and safety considerations, both from personal and traffic perspectives (Moayedi et al., 2013). These indicators not only reflect the physical attributes of an environment but also its suitability for pedestrian use, directly impacting the mobility of the community members, especially those from the vulnerable groups. A graphic illustration summarizing the characteristics and indicators associated with the social structure dimension is shown in Figure 6.

 doi:10.20944/preprints202403.0715.v1

Figure 6. Social structure characteristics and indicators.

3.3.4. Social Equity

Social resilience is essential in improving the quality of life for communities worldwide, rooted in the principle of equitable distribution of societal benefits and challenges (Dobson, 1998). This approach seeks to ensure that every member of society has access to what they need to meet their basic requirements (Morrow, 2008; Saja et al., 2018). At the heart of this resilience is the concept of social equity, defined as the equitable, just, and fair administration of public institutions, including the provision of services, the development of policies, and the allocation of resources (Heckert, 2013; Wooldridge & Gooden, 2009). Recognizing and applying social equity principles is crucial for creating resilient societies where fairness and justice underpin the collective well-being, ensuring that resilience is not just about recovery and adaptation but also about inclusive growth and equitable progress.

Urban resilience and inclusivity are hindered by deep-rooted inequalities, with stressors associated with climate change and disasters falling disproportionately on poor and disadvantaged communities, including people of color, those with disabilities, and women, who often lack access to vital services and infrastructure. These spatial, social, and economic divides limit cities' abilities to withstand and recover from adversities, emphasizing the urgent need for addressing these disparities (Bolin & Kurtz, 2018; Meerow, 2020). There are numerous initiatives focused on promoting resilience and equity through various programs and initiatives aimed at supporting sustainable urban development and disaster risk reduction globally (Kimic & Ostrysz, 2021; Ncube & Arthur, 2021).

Many cities are experiencing environmental degradation and social inequity and are turning to BGI to enhance resilience and improve health, wellbeing, and livability (Kimic & Ostrysz, 2021; Ncube & Arthur, 2021; O'Donnell et al., 2021). Despite the increasing recognition of the benefits of BGI, there is a growing decline in greenspace per capita in many urban areas (Administrator, 2023; Ambrey, 2016). Where greenspace exists, its distribution frequently lacks equity (Zuniga-Teran & Gerlak, 2019), with disparities in access and the extent of available space often aligned with differences in income, ethnic-racial backgrounds, age, gender, and disability (Heynen et al., 2006; Rigolon, 2016; Wolch et al., 2014).

For BGI to contribute effectively and equitably to social resilience, they must be designed and managed to be inclusive, ensuring accessibility, safety, and relevance to the diverse needs and preferences of the entire community, including vulnerable and underrepresented groups (Meheta & Mahato, 2021; Rigolon et al., 2022). The fair access and inclusion of these spaces is recognized as a social justice issue (Rigolon, 2016) because BGI plays an essential role in health and resilience (Jennings & Bamkole, 2019). Studies have shown that communities with greater access to green space report better health outcomes (Jennings & Bamkole, 2019), with many of these outcomes associated with social support and increased contact with others (Jennings & Bamkole, 2019). However, vulnerable communities who are most in need of access to these spaces (Kuo et al., 2018) are less likely to live near BGI (Heynen et al., 2006; Zhang et al., 2022) and have fewer resources to travel to these areas (Hartig et al., 2014). Without equitable access and inclusion, specific groups face a disproportionate exclusion and disadvantage in the benefits of BGI (Braveman et al., 2017) rendering these key characteristics for social equity the proposed framework.

 doi:10.20944/preprints202403.0715.v1

Fair access encompasses the availability of fundamental needs and basic services, including health and wellbeing (Saja et al., 2018). Inclusion involves enhancing access to societal participation and resources, particularly for disadvantaged individuals, aiming to improve their opportunities (De Haas et al., 2021). Indicators of fair access and inclusiveness encompass the availability and distribution of BGI spaces, ensuring they meet the diverse needs of all community segments. This involves measuring key aspects like size, distribution, and accessibility that are critical for informed, sustainable planning (Lang et al., 2020). Metrics such as size and distribution are extensively used in various public health (Bell et al., 2014; Kondo et al., 2018; Nutsford et al., 2013) and urban planning (Cutts et al., 2009; Konijnendijk, 2023; Pamukcu-Albers et al., 2021) studies, as well as recommended by the European Office of the World Health Organization.

Characterization of BGI through a description and subsequent classification of amenities/use type plays a crucial role in understanding and enhancing inclusivity. This indicator serves as an inventory component to understand the diversity of BGI. The presence of green space does not inherently ensure its accessibility or suitability for diverse groups, underscoring the importance of evaluating how parks meet the diverse needs of the community (B. Pfefferbaum et al., 2017; Schindler et al., 2018). A graphic illustration summarizing the characteristics and indicators associated with the social equity dimension is shown in Figure 7.

Figure 7. Social equity characteristics and indicators.

4.1. BGI Social Resilience Framework

The BGI Social Resilience Framework as depicted in Figure 8 is an innovative integration of important BGI characteristics and indicators contributing to social resilience. The framework is shaped by the 5S framework of Saja et al. (2018) and the practitioner framework of Kwok et al. (2016), with the literature review bridging gaps, but it is fundamentally developed by a distinct analysis that draws upon BGI literature.

The BGI Social Resilience Framework's architecture is based on the 5S framework's three-tiered approach of dimensions, characteristics, and indicators, yet it broadens this structure by establishing interrelationships between dimensions. These relationships facilitate the introduction of a fourth tier dedicated to guiding measurement methodologies, thereby enhancing the framework's applicability in BGI. The BGI Social Resilience Framework aligns with the practitioner framework's structural (physical) and cognitive (values) conceptualization and its emphasis on the subjective dimensions.

The BGI Social Resilience Framework stands apart in its specificity to the BGI context and its community-centric scale, emphasizing not just the physicality and connectivity of spaces but also the interplay of community values, practices, and the demographics of those who engage with these spaces. Unlike these influencing frameworks, the BGI Social Resilience Framework moves beyond a disaster centric view with a stronger emphasis on broader concepts of resilience such as sustainability and well-being, reflecting the inherent social advantages of BGI.

 doi:10.20944/preprints202403.0715.v1

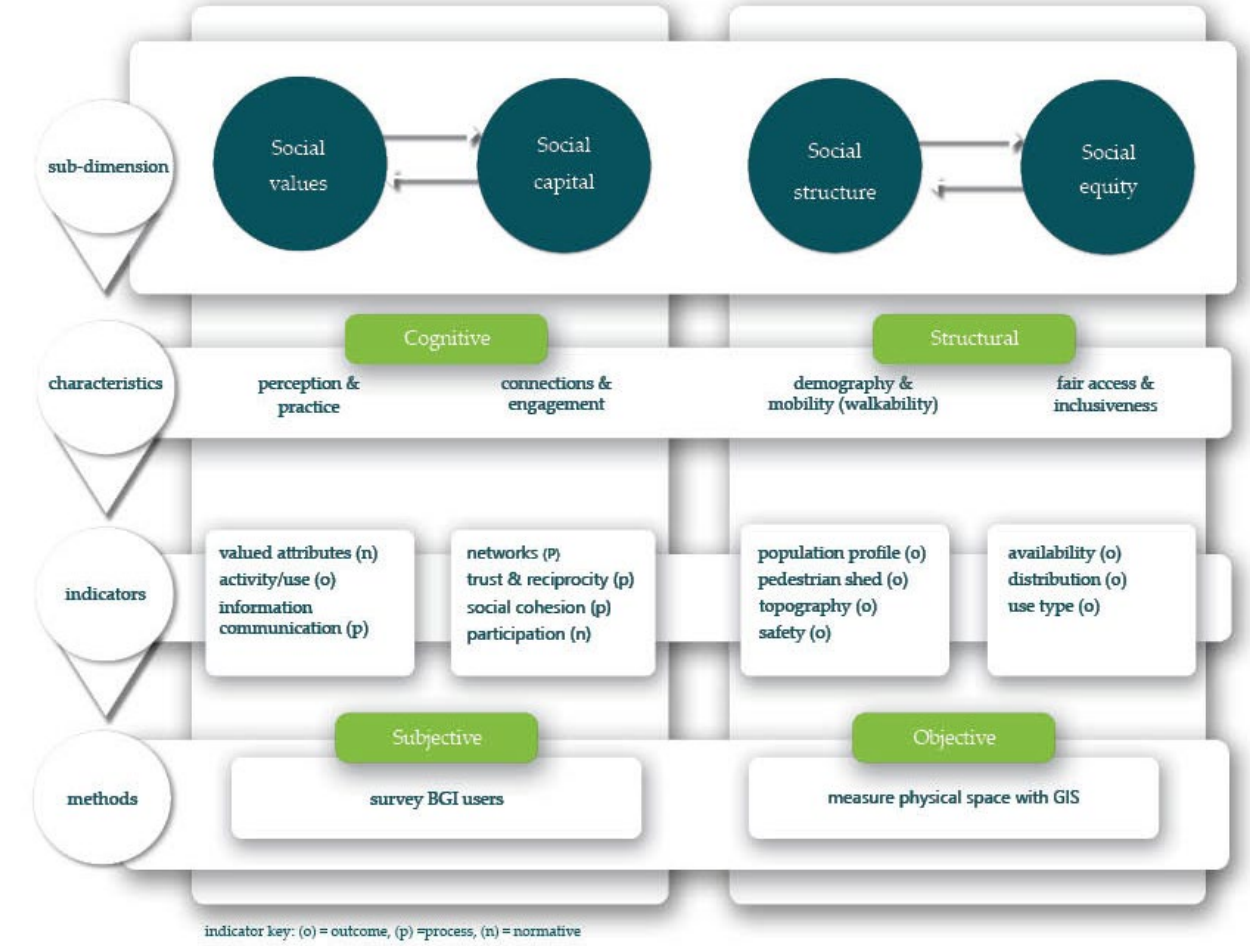

Figure 8. BGI Social Resilience Framework.

4.2.1. Synthesizing Concepts, Application Context, and Measurement Type

Conceptualization

The BGI Social Resilience Framework is framed using cognitive and structural elements relating to social systems. Structural characteristics pertain to 'demographics and walkability' and "fair access & inclusiveness,' which are quantifiable and relate to the physical availability and layout of BGI. Cognitive characteristics, such as 'practice & perceptions' and 'connections & engagement,' provide insights into how communities interact with and value BGI. While there are other conceptualizations identified in the literature review, encompassing structural and cognitive characteristics allows the framework to bridge the gap between the tangible aspects of BGI and the community's perception and engagement with these spaces. This approach enhances the understanding of how BGI influences social resilience by underscoring the importance of integrating the organic complexity of the physical environment with social fabric needed foster community resilience.

The structural dimension supports the measurement of tangible elements such as BGI resource availability, distribution, and access, which are critical for the practical support of a community's resilience. Meanwhile, the cognitive dimension captures the less tangible but equally vital aspects of social trust, community engagement, and place attachment, essential for the social cohesion and collective efficacy required for a community to thrive. By integrating these two dimensions, the framework encompasses the physical underpinnings of resilient communities and the social dynamics that enable them to adapt and transform in the face of challenges, making it an optimal

 doi:10.20944/preprints202403.0715.v1

choice for a holistic understanding of how BGI contributes to building social resilience in the community.

There are other socially relevant attributes and connections from other conceptualizations that are integrated into the structural and cognitive framework. These include an emphasis on social capital (capital-based conceptualization) and interconnection of social attributes (socially interconnection dimension conceptualization). While the framework does not directly measure concepts like coping, adapting, and transforming, their importance is implicitly recognized, as social capital and social values are acknowledged as crucial dimensions for effective coping, adapting, and recovering post-disturbance, (Adger, 2000; Chamlee-Wright & Storr, 2009; Hawkins & Maurer, 2011; Nakagawa & Shaw, 2004).

Application

The BGI Social Resilience Framework expands its focus from disaster-centric to encompassing broader resilience concepts like sustainability and well-being, showcasing the social benefits inherent in BGI. The framework prioritizes understanding how BGI's values and perceptions correlate with aspects of community life, such as social capital, over assessing BGI's role in enhancing skills and preparedness for risk management or facilitating community decision-making processes, often highlighted in disaster-oriented frameworks (S. Cutter, 2016; Kwok et al., 2016; Saja et al., 2018). Additionally, it focuses on equity in accessing BGI as a continuous asset for sustainable health and wellbeing, rather than as a resource allocated post-disaster or as a temporary mobilization space (Li et al., 2021; Masuda, 2014; Montgomery et al., 2017). Consequently, this framework addresses the broader challenges of urbanization, climate change, and social fragmentation with a more comprehensive approach to understanding social resilience in BGI.

Measurement Type

The BGI Social Resilience Framework utilizes an indicator method for measuring social resilience. This method is most used in social resilience frameworks (S. Cutter, 2016; Saja et al., 2019) and is the preferred approach of agencies and practitioners (Saja et al., 2018). The indicator method is best suited for measuring the attributes and understanding the interrelationships between dimensions identified in the new framework.

The indicators within the framework are categorized to align with those outlined in the literature: outcome, process and normative (Copeland et al., 2020; Saja et al., 2018). Outcome indicators like 'social cohesion' and 'population profile' offer a measure of the results of BGI initiatives, while process indicators track the ongoing activities and engagement within BGI. Normative indicators such as 'valued attributes' and 'fair access & inclusiveness' compare the current state of BGI against the societal ideals and standards for inclusivity and equity, ensuring the framework is attuned to the community's aspirations.

4.2.2. Integrating Tools and Insights through Methodologies

In their subsequent study, Saja et al. (2019) emphasizes the importance of identifying specific tools for measuring resilience indicators, introducing an additional tier in the BGI Social Resilience Framework organizational structure. This fourth tier encompasses diverse methodological approaches that elucidate the tangible and intangible social dimensions of BGI. This expanded framework employs qualitative and quantitative methods to understand community interactions and physical infrastructure of BGI. Through this mixed methodological approach, the framework offers a robust mechanism for evaluating the role of BGI in fostering social resilience, combining the depth of qualitative insights with the precision of quantitative spatial analysis.

In the qualitative domain, characteristics and indicators tied to social values and social capital capture the subjective experiences of individuals. Surveys are particularly valuable in this regard, providing a direct avenue for gathering nuanced insights into perceptions, preferences, and practices within BGI spaces, as demonstrated in studies by Fonger et al. (2019), Gobster (2004), Sang et al.

 doi:10.20944/preprints202403.0715.v1

(2016), and Samsun et al. (2022). These tools enable qualitative data collection, offering a window into how community members engage with and value their green spaces, thereby contributing to a comprehensive understanding of BGI's impact on social resilience.

In contrast, the quantitative aspect of the methodology focuses on the spatial and physical characteristics of BGI, employing Geographic Information Systems (GIS) to analyses data on the size, distribution, and accessibility of these spaces GIS-based methods are often used to facilitate a systematic and objective measurement of BGI attributes within a spatial context (Moseley et al., 2013; Nutsford et al., 2016; Pallathadka et al., 2022; Richardson et al., 2010).This spatial approach is critical for sustainable urban planning, allowing for the visualization of BGI distribution across different community areas to identify areas of inequity and guide targeted interventions to ensure equitable access to BGI for all community members.

5. Conclusions

The BGI Social Resilience Framework addresses the existing gap in understanding and measuring social resilience within BGI contexts while broadening the scope to encompass a well-being-oriented perspective of resilience. It presents a 'resilient bounce forward' approach where communities progress toward a more robust and interconnected future. This framework is developed from referenced studies that advocate for solutions that strengthen social connections and ties and consider the dynamic interplay between BGI's tangible infrastructure and the community's social fabric, values, needs, and aspirations. It champions community unity, collaboration, and fairness, all of which are crucial for fostering the ability to effectively cope with, adapt to, and transform in response to challenges (Moseley et al., 2013; Nutsford et al., 2016; Pallathadka et al., 2022; Richardson et al., 2010). This strategic emphasis positions the framework can guide the development and evaluation of BGI spaces that are resilient and inclusive, catering to the diverse needs and preferences of urban spaces.

Centered around BGI, the framework fosters a setting where community connections and inclusivity thrive, directly supporting UN SDG 11's vision for cities that are inclusive, safe, sustainable, and resilient, showcasing a forward-thinking approach to where and how urban development unfolds. Specifically, it directly addresses goal SDG 11.7, emphasizing the importance of providing safe, inclusive, accessible green and public spaces. Indicators for this goal include the extent of green space, removing barriers to access, and increasing the number of people from different demographic groups, most notably women, children, older people, and people with disabilities accessing these spaces. The BGI Social Resilience Framework stands out for its capability to help tailor physical spaces to the unique characteristics of communities, thereby amplifying social resilience in a manner that is both equitable and context sensitive. It encapsulates a forward-looking approach that integrates robust urban planning with a sensitivity to the social fabrics of community spaces, ensuring that social resilience is built into the foundation of urban life.

Subsequent research will apply the framework within a distinct context to assess its practical value. The BGI Social Resilience Framework offers a practical and comprehensive tool that bridges the gap between academic research and on-the-ground application by integrating a mixed-methods approach that combines qualitative insights with quantitative data. This approach is set to be tested and evaluated to determine its impact on fostering social resilience across both established and emerging urban environments. Such empirical testing highlights the framework's capacity to guide urban planning and BGI strategies by offering insights that are both evidence-based and tailored to the demands of the environment. Ultimately, it aims to provide a comprehensive and adaptable tool that enables practitioners to identify and leverage key aspects of social resilience that are most pertinent to the unique needs of their communities.

Author Contributions: This research is part of Angie Campbell's dissertation. Conceptualization, AC.; methodology, AC.; formal analysis.; writing—original draft preparation, AC; writing—review and editing, VC and MS.; visualization, AC.; supervision, VC and MS; funding acquisition, VC. All authors have read and agreed to the published version of the manuscript.

Funding: This project was supported by Te Hiranga Rū QuakeCoRE, an Aotearoa New Zealand Tertiary Education Commission-funded Centre. This is QuakeCoRE publication number XXX (to be identified as we get closer to publication).

References

1. Abbass, K., Qasim, M. Z., Song, H., & Muntasir. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, *29*, 42539–42559.
2. Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, *24*(3), 347–364. https://doi.org/10.1191/030913200701540465
3. Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography;*, *79*(4), 387.
4. Adger, W. N., Barnett, J., Brown, K., Marshall, N., & O'Brien, K. (2013). Cultural dimensions of climate change impacts and adaptation. *Nature Climate Change*, *3*(2), 112–117. https://doi.org/10.1038/nclimate1666
5. Administrator, P. C. E. (2023, March 20). *Aotearoa's cities are losing their leaves*. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/e3f4c7a2f8534d4e877d140ec209514c
6. Alberti, M., Marzluff, J. M., Schulenberger, E., Bradley, G., Ryan, C., & Zumbrunnen, C. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. *BioScience*, *53*(12), 1169–1179.
7. Aldrich, D. P. (2010). Fixing Recovery: Social Capital in Post-Crisis Resilience. *Journal of Homeland Security, Forthcoming*.
8. Aldrich, D. P., & Meyer, M. A. (2014). Social capital and community resilience. *American Behavioral Scientist*, *59*(2), 254–269.
9. Aldrich, D. P., & Meyer, M. A. (2015). Social Capital and Community Resilience. *American Behavioral Scientist*, *59*(2), 254–269. https://doi.org/10.1177/0002764214550299
10. Alsheri, S. A., Rezgui, Y., & Li, H. (2015). Delphi-based consensus study into framework of community resilience to disaster. *Natural Hazards*, *75*, 2221–2245.
11. Altschuler, A., & Somkin, C. P. (2004). Local services and amenities, neighborhood social captital, and health. *Social Science and Medicine*, *59*, 1219–1229.
12. Ambrey, C. L. (2016). Urban greenspace, physical activity and wellbeing: The moderating role of perceptions of neighbourhood affability and incivility. *Land Use Policy*, *57*, 638–644. https://doi.org/10.1016/j.landusepol.2016.06.034
13. Arbon, P. (2014). Developing a model and tool to measure community disaster resilience. *Australian Journal of Emergency Management*, *29*(4), 12–16.
14. Armitage, D., Bene, C., Charles, A. T., Johnson, D., & Allison, E. H. (2012). The Interplay of Well-being and Resilience in Applying a Social-Ecological Perspective. *Ecology and Society*, *17*(4).
15. Barnett, J. (2001). Adapting to climate change in Pacific Island countries: The problem of uncertainty. *World Development*, *29*(6), 977–933.
16. Beatley, T., & Newman, P. (2013). Biophilic Cities Are Sustainable, Resilient Cities. *Sustainability*, *5*(8), 3328–3345.
17. Bell, S. L., Phoenix, C., Lovell, R., & Wheeler, B. W. (2014). Green space, health and wellbeing: Making space for individual agency. *Health & Place*, *30*, 287–292. https://doi.org/10.1016/j.healthplace.2014.10.005
18. Berke, P., Newman, G., Lee, J., & Combs, T. (2015). Evaluation of Networks of Plans and Vulnerability to Hazards and Climate Change: A Resilience Scorecard. *Journ of American Planning Association*, *81*(4), 287–302.
19. Berry, H. L., & Welsh, J. A. (2010). *Social capital and health in Australia: An overview from the household, income, and labour dynamics in Australia survey*. *70*(4), 588–596.
20. Bolin, B., & Kurtz, L. (2018). Race, class, ethnicty, and disaster vulnerabilty. In *Handbook of disaster research* (pp. 181–203).
21. Boyd, E., Riyanti, D., & Gemenne, F. (2022). *IPCC Sixth Assessment Report Impacts, Adaptation and Vulnerability: Chapter 8 Poverty, livelihoods and sustainable development*. Intergovernmental Panel on Climate Change.
22. Braveman, P., Arkin, E., Orleans, T., & Proctor, D. (2017). *What is Health Equity? And what difference does it make?*
23. Broeder, L. den, South, J., & Rothoff, A. (2022). Community engagement in deprived neighbourhoods during the COVID-19 crisis: Perspectives for more resilient and healthier communities. *Health Promotion International*, *37*(2).
24. Brown, H. I. (1979). *Perception, theory, and commitment: The new philosophy of science*. University of Chicago Press.

25. Burton, C. (2015). A validation of metrics for community resilience to natural hazards and disasters using the recovery from Hurricane Katrina as a case study. *Annals of the Association of American Geographers*, *105*(1), 67–86.
26. Campbell, L. K., & Wisen, A. (2009). *Restorative Commons: Creating Health and Well-Being through Urban Landscapes* (Volume 39). Government Printing Office.
27. Cecchini, M., Cividino, S., & Turco, R. (2019). *Population Age Structure, Complex Socio-Demographic Systems and Resilience Potential: A Spatio-Temporal, Evenness-Based Approach*. *11*(7), 2050.
28. Chamlee-Wright, E., & Storr, V. H. (2009). There's no place like New Orleans": Sense of place and community recovery in the Ninth Ward after Hurricane Katrina. *Journal of Urban Affairs*, *31*(5), 615–634.
29. Chandra, A., Williams, M., Plough, A., Stayton, A., Wells, K., & Horta, M. (2013). GettingActionableAboutCommunityResilience:TheLosAngeles CountyCommunityDisasterResilienceProject. *American Journal of Public Health*, *103*(7), 1181–1189.
30. Copeland, S., Comes, T., Bach, S., Nagenborg, M., & Shulte, Y. (2020). Measuring social resilience: Trade-offs, challenges and opportunities for indicator models in transforming societies. *International Journal of Diaster Risk Reduction*, *51*, 101799.
31. Cox, R. S., & Perry, K.-M. E. (2011). Like a Fish Out of Water: Reconsidering Disaster Recovery and the Role of Place and Social Capital in Community Disaster Resilience. *American Journal of Community Psychology*, *48*(3–4), 395–411. https://doi.org/10.1007/s10464-011-9427-0
32. Curran, W., & Hamilton, T. (2012). Just green enough: Contesting environmental gentrificaiton in Greenpoint, Brooklyn. *Local Environment*, *17*(9), 1027–1042.
33. Cutter, S. (2016). The landscape of disaster resilience indicators in the USA. *Natural Hazards*, *80*(2), 741–758.
34. Cutter, S., Ash, K. D., & Emrich, C. T. (2014). The geographies of community disaster resilience. *Global Environmental Change*, *29*, 65–77.
35. Cutter, S., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, *18*(4), 598–606.
36. Cutter, S. L., & Derakhshan, S. (2021). Temporal and spatial change in disaster resilience in US counties, 2010–2015. *Environmental Hazards and Resilence*, 51–70.
37. Cutts, B. B., Darby, K. J., Boone, C. G., & Brewis, A. (2009). City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access. *Social Science & Medicine*, *69*(9), 1314–1322. https://doi.org/10.1016/j.socscimed.2009.08.020
38. Dade, M. C., Mitchell, M. G. E., Brown, G., & Rhodes, J. (2020). The effects of urban greenspace characteristics and socio-demographics vary among cultural ecosystem services. *Urban Forestry & Urban Greening*, *49*, 126641.
39. De Haas, W., Hassink, J., & Stuiver, M. (2021). The Role of Urban Green Space in Promoting Inclusion: Experiences From the Netherlands. *Frontiers in Ecology and the Environment*, *9*.
40. Dobson, A. (1998). *Justince and the environment:Conceptions of environmenal Sustainabilty and theories of distributive justice*. Claredon Press.
41. Dreiseitl, H., & Wanshura, B. (2016). *Strengthening Blue-Green Infrastructure In Our Cities*. Ramboll.
42. Elmqvist, T., Andersson, E., & Frantzeskaki, N. (2019). Sustainability and resilience for transformation in the urban century. *Nature Sustainabilty*, *2*(4), 267–273.
43. Fagg, J., Curtis, S., Stansfeld, S. A., Cattell, V., Tupuola, A.-M., & Arephin, M. (2008). Area social fragmentation, social support for individuals and psychosocial health in young adults: Evidence from a national survey in England. *Social Science & Medicine*, *66*(2), 242–254. https://doi.org/10.1016/j.socscimed.2007.07.032
44. Feinberg, A., Ghorbani, A., & Herder, P. (2023). Commoning toward urban resilience: The role of trust, social cohesion, and involvement in a simulated urban commons setting. *Journal of Urban Affairs*, *45*(2), 142–167.
45. Fongar, Aamodt, Randrup, & Solfjeld. (2019). Does Perceived Green Space Quality Matter? Linking Norwegian Adult Perspectives on Perceived Quality to Motivation and Frequency of Visits. *International Journal of Environmental Research and Public Health*, *16*(13), 2327. https://doi.org/10.3390/ijerph16132327
46. Forrest, R., & Kearns, A. (2001). Social Cohesion, Social Capital, and the Neighbourhood. *Urban Studies*, *38*, 2125.
47. Forsyth, A. (2015). What is a walkable place? The walkability debate in urban design. *URBAN DESIGN International*, *20*(4), 274–292. https://doi.org/10.1057/udi.2015.22
48. Foster, K. A., Pitner, R., Freedman, D. A., Bell, B. A., & Shaw, T. C. (2015). Spatial Dimensions of Social Capital. *City & Community*, *14*(4), 392–409. https://doi.org/10.1111/cico.12133
49. Foster, Lowe, & Winkleman. (2011). The value of green infrastructure for urban climate adaptation. *Centre for Clean Air Policy*, *750*(1), 1–52.
50. Francis, J., Giles-Corti, B., Wood, L., & Knuiman, M. (2012). Creating sense of community: The role of public space. *Journal of Environmental Psychology*, *32*(4), 401–409.

51. Francis, M., Cashdan, L., & Paxson, L. (1984). *Community open spaces: Greening neighborhoods through community action and land conservation*. Island Press.
52. Gardner, J. (2019). The inclusive healthy places framework: A new tool for social resilence and public infrastructure. *Biophilic Cities Journal*, *2*(2), 10–15.
53. Gehl, J. (2013). *Cities for people*. Island Press.
54. Ghofrani, Z., Sposito, V., & Faggian, R. (2017). A Comprehensive Review of Blue-Green Infrastructure Concepts. *International Journal of Environment and Sustainability*, *6*(1). https://doi.org/10.24102/ijes.v6i1.728
55. Gobster, P. H., & Westphal, L. M. (2004). The human dimensions of urban greenways: Planning for recreation and related experiences. *Landscape and Urban Planning*, *68*(2–3), 147–165. https://doi.org/10.1016/S0169-2046(03)00162-2
56. Guadagno, L. (2016). Human mobility in the Sendai Framework. *International Journal of Disaster Risk Science*, *7*, 30–40.
57. Gunderson, L. H. (2001). *Panarchy: Understanding transformations in human and natural systems*. Island Press.
58. Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and Health. *Annual Review of Public Health*, *35*(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443
59. Hawkins, R. L., & Maurer, K. (2011). Unravelling social capital: Disentangling a concept for social work. *British Journal of Social Work*, *42*(2), 353–370.
60. Heckert, M. (2013). Access and Equity in Greenspace Provision: A Comparison of Methods to Assess the Impacts of Greening Vacant Land: Access and Equity in Greenspace Provision. *Transactions in GIS*, *17*(6), 808–827. https://doi.org/10.1111/tgis.12000
61. Heynen, N., Perkins, H. A., & Roy, P. (2006). The political ecology of uneven urban green space: The impact of political economy on race and ethnicity in producing environmental inequality in Milwaukee. *Urban Affairs Review*, *42*(1), 3–25.
62. Hunter, R. F., Cleland, C., Cleary, A., & Droomers, M. (2019). Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environment International*, *130*, 104923.
63. Hyyppä, M. T. (2010). *Healthy Ties*. Springer Netherlands. https://doi.org/10.1007/978-90-481-9606-7
64. Imperiale, A. J., & Vanclay, F. (2016). Using social impact assessment to strengthen community resilience in sustainable rural development in mountain areas. *Mountain Research and Development*, *36*(4), 431–442.
65. Ingram, J., & Hamilton, C. (2014). *Planning for Climate Change: A strategic, values-based approach for urban Planners* (CITIES AND CLIMATE CHANGE INITIATIVE Tool Series). United Nations Human Settlements Programme (un-habitat).
66. Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Green Space: An Avenue for Health Promotion. *International Journal of Environmental Research and Public Health*, *16*(3), 452. https://doi.org/10.3390/ijerph16030452
67. Jewett, R. L., Mah, S. M., Howell, N., & Larsen, M. M. (2021). Social Cohesion and Community Resilience During COVID-19 and Pandemics: A Rapid Scoping Review to Inform the United Nations Research Roadmap for COVID-19 Recovery. *International Journal of Health Services*, *51*(3), 325–336. https://doi.org/10.1177/0020731421997092
68. Joerin, J., Shaw, R., Takeuchi, Y., & Krishnamurthy, R. (2014). The adoption of a Climate Disaster Resilience Index in Chennai, India. *Diasters*, *38*(3), 540–561.
69. Johnson, J. P., Lenartowicz, Th., & Aqud, S. (2006). Cross-cultural competence in international business: Toward a definition and a model. *Journal of International Busienss Studies*, *37*(4), 525–543.
70. Jones, L., & Tanner, T. (2017). Subjective resilience: Using perceptions to quantify household resleince to climate extremes and disasters. *Regional Environment Change*, *17*, 229–243.
71. Jurjonas, M., & Seekamp, E. (2018). Rural coastal community resilience: Assessing a framework in easteer North Carolina. *Ocean & Coastal Managemetn*, 137–150.
72. Kabisch, N., Korn, H., Stadler, J., & Bonn, A. (Eds.). (2017). *Nature-Based Solutions to Climate Change Adaptation in Urban Areas: Linkages between Science, Policy and Practice*. Springer International Publishing. https://doi.org/10.1007/978-3-319-56091-5
73. Keck, M., & Sakdapolrak, P. (2013). What is social resilience? Lessons learned and ways forward. *Erdkunde*, *67*(1), 5–19. https://doi.org/10.3112/erdkunde.2013.01.02
74. Kimic, K., & Ostrysz, K. (2021). Assessment of Blue and Green Infrastructure Solutions in Shaping Urban Public Spaces—Spatial and Functional, Environmental, and Social Aspects. *Sustainability*, *13*(19), 11041. https://doi.org/10.3390/su131911041
75. KI-Moon, B. (2010). *International Strategy for Disaster Reduction Summary Annual Report and Financial Statement* [Annual Report]. United Nations.
76. Kondo, M., Fluehr, J., McKeon, T., & Branas, C. (2018). Urban Green Space and Its Impact on Human Health. *International Journal of Environmental Research and Public Health*, *15*(3), 445. https://doi.org/10.3390/ijerph15030445

77. Konijnendijk, C. C. (2023). Evidence-based guidelines for greener, healthier, more resilient neighbourhoods: Introducing the 3–30–300 rule. *Journal of Forestry Research*, *34*(3), 821–830. https://doi.org/10.1007/s11676-022-01523-z
78. Krahn, G. L., Walker, D. K., & Correa-De-Araujo, R. (2015). Persons With Disabilities as an Unrecognized Health Disparity Population. *American Journal of Public Health*, *105*(S2), S198–S206. https://doi.org/10.2105/AJPH.2014.302182
79. Kuo, M., Browning, M. H. E. M., Sachdeva, S., Lee, K., & Westphal, L. (2018). Might School Performance Grow on Trees? Examining the Link Between "Greenness" and Academic Achievement in Urban, High-Poverty Schools. *Frontiers in Psychology*, *9*, 1669. https://doi.org/10.3389/fpsyg.2018.01669
80. Kwok, A. H. (2016). What is 'social resilience'? Perspectives of disaster researchers, emergency management practitioners, and policymakers in New Zealand. *International Journal of Disaster Risk Reduction*.
81. Kwok, A. H., Doyle, E. E. H., Becker, J., Johnston, D., & Paton, D. (2016). What is 'social resilience'? Perspectives of disaster researchers, emergency management practitioners, and policymakers in New Zealand. *International Journal of Disaster Risk Reduction*, *19*, 197–211. https://doi.org/10.1016/j.ijdrr.2016.08.013
82. Lamond, J., & Evertt, G. (2019). Sustainable Blue-Green Infrastructure: A social practice approach to understanding community preferences and stewardship. *Landscape and Urban Planning*, *191*, 103639.
83. Lang, S., Schöpfer, E., & Hölbling, D. (2020). Quantifying and Qualifying Urban Green by Integrating Remote Sensing, GIS, and Social Science Methods. In *Use of Landscape Sciences for the Assessment of Environmental Security*. Springer International Publishing.
84. Lee, Y.-C., & Kim, K.-H. (2015). Attitudes of Citizens towards Urban Parks and Green Spaces for Urban Sustainability: The Case of Gyeongsan City, Republic of Korea. *Sustainability*, *7*(7), 8240–8254.
85. Leichenko, R. M. (2011). Climate Change and Urban Resilience. *Current Opinion in Environmental Sustainability*, *3*(3), 164–168.
86. Leong, C.-H., & Malone-Lee, L.-C. (Eds.). (2020). *Building Resilient Neighbourhoods in Singapore: The Convergence of Policies, Research and Practice*. Springer Singapore. https://doi.org/10.1007/978-981-13-7048-9
87. Li, D., Newman, G., Zhang, T., Zhu, R., & Horney, J. (2021). Coping with post-hurricane mental distress: The role of neighborhood green space. *Social Science & Medicine*, *281*, 114084.
88. Lo, A. Y. H., & Jim, C. Y. (2012). Citizen attitude and expectation towards greenspace provision in compact urban milieu. *Land Use Policy*, *29*(3), 577–586. https://doi.org/10.1016/j.landusepol.2011.09.011
89. Lockwood, M. (2005). Integration of natural area values: Conceptual foundations and methodological approaches. *Australasian Journal of Environmental Management*, *12*(sup1), 8–19.
90. Lopez, B., Kennedy, C., & McPhearson, T. (2020). ***Parks are Critical Urban Infrastructure: Perception and Use of Urban Green Spaces in NYC During COVID-19*** [Preprint]. SOCIAL SCIENCES. https://doi.org/10.20944/preprints202008.0620.v1
91. Louv, R. (2005). Nature deficit. *Orion*, *70*, 71.
92. Lyon, C. (2014). Place systems and social resilience: A framework for understanding place in social adaptation, resilience, and transformation. *Society & Natural Resources*, 1009–1023.
93. Marin, A., & Wellman, B. (2011). Soail network analysis: An introduction. In *The SAGE handbook of social network analysis* (pp. 11–25).
94. Maseda, M., Neira, I., & Jimenez. (2012). Social Capital and Subjective Wellbeing in Europe: A New Approach on Social Capital. *Social Indicators Research*.
95. Masuda, N. (2014). Disaster refuge and relief urban park system in Japan. *Landscape Architecture Frontiers*, *2*(4), 52–61.
96. Matthews, V., Longman, J., Bennett-Levy, J., Braddon, M., Passey, M., Bailie, R. S., & Berry, H. L. (2020). Belonging and Inclusivity Make a Resilient Future for All: A Cross-Sectional Analysis of Post-Flood Social Capital in a Diverse Australian Rural Community. *International Journal of Environmental Research and Public Health*, *17*(20), 7676. https://doi.org/10.3390/ijerph17207676
97. Mayunga, J. (2007). Understanding and applying the concept of community disaster resilience: A capital-based approach. *Summer Academy for Social Vulnerability and Resilience Building*, *1*(1), 1–16.
98. McMillan, D. W., & Chavis, D. M. (1986). *Sense of community: A definition and theory*. *14*(1), 6–23.
99. Meerow, S. (2020). The politics of multifunctional green infrastructure planning in New York City. *Cities*, *100*, 102621. https://doi.org/10.1016/j.cities.2020.102621
100. Meheta, V., & Mahato, B. (2021). Designing urban parks for inclusion, equity, and diversity. *Journal of Urbanism*, *14*(4), 457–489.
101. Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being: Opportunities and Challenges for Business and Industry* [Assessment]. World Resources Institute. http://www. millenniumassessment. org/en/index. aspx

102. Miller, S. (2020). Greenspace volunteering post-disaster: Exploration of themes in motivation, barriers, and benefits from post-hurricane park and garden volunteers. *Journal of Environmental Planning and Management*, *63*(11), 2004–2021.
103. Minh Pham, T., Kondor, I., Hanel, R., & Thurner, S. (2020). The effect of social balance on social fragmentation. *Journal of The Royal Society Interface*, *17*(172), 20200752. https://doi.org/10.1098/rsif.2020.0752
104. Moayedi, F., Zakaria, & Bigah. (2013). Conceptualising the indicators of walkability for sustainable transportation. *Journal Technology*, *65*(3), 85–90.
105. Moher, D., Libertati, A., & Tetzlaff, J. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine*, *151*(4), 264–269.
106. Montgomery, R., Wesener, A., & Davies, F. (2017). Bottom-up governance after a natural disaster: A temporary post-earthquake community garden in Central Christchurch, New Zealand. *NA*, *28*(3).
107. Morrow, B. H. (2008). *Community resilience: A social justice perspective* [4].
108. Moseley, D., Marzano, M., Chetcuti, J., & Watts, K. (2013). Green networks for people: Application of a functional approach to support the planning and management of greenspace. *Landscape and Urban Planning*, *116*, 1–12. https://doi.org/10.1016/j.landurbplan.2013.04.004
109. Mukherjee, M., & Takara, K. (2018). Urban green space as a countermeasure to increasing urban risk and the UGS-3CC resilience framework. *International Journal of Disaster Risk Reduction*, *28*, 854–861. https://doi.org/10.1016/j.ijdrr.2018.01.027
110. Nadel, S. F. (2013). *The theory of social structure* (Vol. 8).
111. Nakagawa, Y., & Shaw, R. (2004). Social capital: A missing link to disaster recovery. *International Journal of Mass Emergencies and Disasters*, *22*(1), 5–34.
112. Ncube, S., & Arthur, S. (2021). Influence of Blue-Green and Grey Infrastructure Combinations on Natural and Human-Derived Capital in Urban Drainage Planning. *Sustainability*, *13*(5), 2571. https://doi.org/10.3390/su13052571
113. Norris, F. H., Stevens, S. P., Pfefferbaum, K. F., Wyche, R., & Pfefferbaum, R. L. (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology*, *41*, 127–150.
114. Nutsford, D., Pearson, A. L., & Kingham, S. (2013). An ecological study investigating the association between access to urban green space and mental health. *Public Health*, *127*(11), 1005–1011. https://doi.org/10.1016/j.puhe.2013.08.016
115. Nutsford, D., Pearson, A. L., Kingham, S., & Reitsma, F. (2016). Residential exposure to visible blue space (but not green space) associated with lower psychological distress in a capital city. *Health & Place*, *39*, 70–78. https://doi.org/10.1016/j.healthplace.2016.03.002
116. Obrist, B., Pfeiffer, C., & Henley, R. (2010). Multi-layered social resilience: A new approach in mitigation research. *Progress in Development Studies*, *10*(4), 283–293.
117. Ode Sang, Å., Knez, I., Gunnarsson, B., & Hedblom, M. (2016). The effects of naturalness, gender, and age on how urban green space is perceived and used. *Urban Forestry & Urban Greening*, *18*, 268–276. https://doi.org/10.1016/j.ufug.2016.06.008
118. O'Donnell, E., Netusil, N., Chan, F., Dolman, N., & Gosling, S. (2021). International Perceptions of Urban Blue-Green Infrastructure: A Comparison across Four Cities. *Water*, *13*(4), 544. https://doi.org/10.3390/w13040544
119. O'sullivan, R., Burns, A., Leavy, G., & Leroi, I. (2021). Impact of the COVID 19 pandemic on lonliness and social isolation: A multi-country study. *International Journal of Environmental Research and Public Health*, *18*(19), 9982.
120. Pallathadka, A., Pallathadka, L., Rao, S., Chang, H., & Van Dommelen, D. (2022). Using GIS-based spatial analysis to determine urban greenspace accessibility for different racial groups in the backdrop of COVID-19: A case study of four US cities. *GeoJournal*, *87*(6), 4879–4899. https://doi.org/10.1007/s10708-021-10538-8
121. Pamukcu-Albers, P., Ugolini, F., La Rosa, D., Grădinaru, S. R., Azevedo, J. C., & Wu, J. (2021). Building green infrastructure to enhance urban resilience to climate change and pandemics. *Landscape Ecology*, *36*(3), 665–673. https://doi.org/10.1007/s10980-021-01212-y
122. Parsons, M., Thoms, M., Flotemersch, J., & Reid, M. (2016). Monitoring the resilience of rivers as social-ecological systems: A paradigm shift for river assessment in the twenty-first century. *River Science: Research and Managemetn for the 21st Century*, 197–220.
123. Paton, D. (2006). Disaster resilience: Building capacity to co-exist with natural hazards and their consequences. In *Disaster resilience: An integrated approach* (pp. 3–10).
124. Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, *15*(4), 308–319. https://doi.org/10.1016/j.gloenvcha.2005.02.001
125. Pfefferbaum, B., Van Horn, R. L., & Pfefferbaum, R. L. (2017). A Conceptual Framework to Enhance Community Resilience Using Social Capital. *Clinical Social Work Journal*, *45*(2), 102–110. https://doi.org/10.1007/s10615-015-0556-z

126. Pfefferbaum, R. L., Pfefferbaum, B., Van Horn, R. L., Norris, F. H., & Reissman, D. B. (2013). The communities advancing resilience toolkit (CART. *Journal of Public Health Management Practice*, *19*(3), 250–258.
127. Phillips, A., Khan, A. Z., & Canters. (2021). Use-Related and Socio-Demographic Variations in Urban Green Space Preferences. *Sustainability*, *13*, 3461.
128. Pike, A., Dawley, S., & Tomaney, J. (2010). Resilience, Adaptation and Adaptability. *Cambridge Journal of Regions, Economy and Society*, *3*(1), 59–70.
129. Population Division of the UN Department of Economic and Social Affairs. (2018). *2018 Revision of World Urbanization Prospects*. World Urbanization Prospects. https://population.un.org/wup/
130. Prior, T., & Hagmann, J. (2014). Measuring resilience: Methodological and political challenges of a trend security concept. *Journal of Risk Research*, *17*(3), 281–298.
131. Putnam, R. (1993). The prosperous community: Social capital and public life. *The American Prospect*, *4*(13 Spring).
132. Putnam, R. (2000). *Bowling alone: The collapse and revival of American community.* Simon and schuster.
133. Ramsey, I., Stennkamp, M., & Thompson, A. (2016). Assessing community disaster reilience using a balanced scorecard: Lessons learnt from three Australian communities. *Australian Journal of Emergency Management*, *31*(2), 44–49.
134. Ribeiro, P. J. G., & Goncalves, L. A. P. J. (2019). Urban resilience: A conceptual framework. *Sustainable Cities*, *50*, 101625.
135. Richardson, E., Pearce, J., Mitchell, R., Day, P., & Kingham, S. (2010). *RTehseaerchaasrtsicole ciation between green space and cause-specific mortality in urban New Zealand: An ecological analysis of green space utility*.
136. Rigolon, A. (2016). A complex landscape of inequity in access to urban parks: A literature review. *Landscape and Urban Planning*, *153*, 160–169. https://doi.org/10.1016/j.landurbplan.2016.05.017
137. Rigolon, A. (2017). Parks and young people: An environmental justice study of park proximity, acreage, and quality in Denver, Colorado. *Landscape and Urban Planning*, *165*, 73–83. https://doi.org/10.1016/j.landurbplan.2017.05.007
138. Rigolon, A., & Gibson, S. (2021). The role of non-government organisations achieving environmental justic for green and blue spaces. *Landscdapeand Urban Planning*, *205*, 103970.
139. Rigolon, A., Yanez, E., & Aboelata. (2022). "A park is not just a park": Toward counter-narratives to advance equitable green space policy in the United States. *Cities*, *128*, 103792.
140. Roe, J., Thompson, C., Aspinall, P., Brewer, M., Duff, E., Miller, D., Mitchell, R., & Clow, A. (2013). Green Space and Stress: Evidence from Cortisol Measures in Deprived Urban Communities. *International Journal of Environmental Research and Public Health*, *10*(9), 4086–4103. https://doi.org/10.3390/ijerph10094086
141. Rose, A. (2004). Defining and measuring economic resilience to disasters. *Disaster Prevention and Management: An International Journal*, *13*(4), 307–314.
142. Sachs, J., Krull, C., Lafortune, G., & Fuller, G. (2022). *The Sustainable Development Goals Report 2022*. Cambridge University Press.
143. Saja, A. M. A., Goonetilleke, A., Teo, M., & Ziyath. (2019). A critical review of social resilience frameworks in disaster management. *International Journal of Disater Risk Reduction*, *35*, 101096.
144. Saja, A. M. A., Teo, M., Goonetilleke, A., & Ziyath, A. M. (2018). An inclusive and adaptive framework for measuring social resilience to disasters. *International Journal of Disaster Risk Reduction*, *28*, 862–873. https://doi.org/10.1016/j.ijdrr.2018.02.004
145. Samsudin, R., Yok, T. P., & Chua, V. (2022). Social capital formation in high density urban environments: Perceived attributes of neighborhood green space shape social capital more directly than physical ones. *Landscape and Urban Planning*, *227*, 104527. https://doi.org/10.1016/j.landurbplan.2022.104527
146. Scalenghe, R., & Marson, F. A. (2009). The anthropogenic sealing of soils in urban areas. *Landscape and Urban Planning*, *90*(1–2), 1–10.
147. Schiefer, D., & van der Noll, J. (2017). The Essentials of Social Cohesion: A Literature Review. *Social Indicators Research*, *132*(2), 579–603. https://doi.org/10.1007/s11205-016-1314-5
148. Schindler, M., Le Texier, M., & Caruso, G. (2018). Spatial sorting, attitudes and the use of green space in Brussels. *Urban Forestry & Urban Greening*, *31*, 169–184.
149. Schoch-Spana, M., Gill, K., Hosangadi, D., Slemp, C., Burhans, R., Zeis, J., Carbone, E. G., & Links, J. (2019). The COPEWELL Rubric: A Self-Assessment Toolkit to Strengthen Community Resilience to Disasters. *International Journal of Environmental Research and Public Health*, *16*(13).
150. Sempier, T. T., Swan, D. L., Emmer, S. H., & Schneider, M. (2010). *Coastal community resilience index: A community self-assessment, online*.
151. Seymour, E., Curtis, A., Pannell, D., Allan, C., & Roberts, A. (2010). Understanding the role of assigned values in natural resource management. *Australasian Journal of Environmental Management*, *17*(3), 142–153.
152. Sharifi, A. (2016). A critical review of selected tools for assessing community resilience. *Ecological Indicators*, *69*, 629–647.

153. Sharifi, A., & Yamagata, Y. (2016). Urban resilience assessment: Multiple dimensions, criteria, and indicators. *Urban Resilience: A Transformative Approach*, 259–276.
154. Shiva, V. (2006). *Earth democracy: Justice, sustainability and peace*. Zed Books.
155. Surjono, A. Y., Setyono, D. A., & Putri, J. (2021). Contribution of Community Resilience to City's Livability within the Framework of Sustainable Development. *Journal of Environmental Research, Engineering, and Manaagement*, *77*(4), 33–47.
156. Svendsen, E. (2009). Cultivating resilience: Urban stewardship as a means to improving health and well-being. In *Restorative commons: Creating health and well-being through urban landscapes. Gen. Tech Rep. NRS-P-39. US Department of Agriculture,* (pp. 58–87). US Department of Agriculture, Forest Service, Northern Research Station.
157. Svendsen, E., & Campbell, L. K. (2006). *Land-markings: 12 journeys through 9/11 living memorials* (49). US Department of Agriculture, Forest Service.
158. Tidball, K. G., Krasny, M. E., Svendsen, E., Campbell, L. K., & Helphand, K. (2010). *Stewardship, learning, and memory in disaster resilience*. *16*(5–6), 591–609.
159. Twigg, J. (2015). *Disaster risk reduction*. Overseas Development Institute, Humanitarian Policy Group.
160. United Nations, Department of Economic and Social Affairs, Population Division. (2022). *The Sustainable Development Goals: Report 2022*.
161. Urquiza, A., Amigo, C., Billi, M., & Calvo, R. (2021). An Integrated Framework to Streamline Resilience in the Context of Urban Climate Risk Assessment. *Earth's Future*, *9.9*.
162. van Riper, C. J., Sharp, R., Bagstad, K. J., Vagias, W. M., Kwenye, J., Depper, G., & Freimund, W. (2016). *Recreation, Values, and Stewardship: Rethinking Why People Engage in Environmental Behaviors in Parks and Protected Areas:Chapter 19*. 117–122.
163. Vaske, J. J., & Donnelly, M. P. (1999). A Value–Attitude–Behavior Model Predicting Wildland Preservation Voting Intentions. *Society & Natural Resources*, *12*(6), 523- – 537.
164. Vera, E. M., & Speight, S. L. (2003). Multicultural competence, social justice, and counseling psychology: Expanding our roles. *The Counseling Psychologist*, *31*(3), 253–272.
165. Wen, C., Albert, C., & Von Haaren, C. (2018). The elderly in green spaces: Exploring requirements and preferences concerning nature-based recreation. *Sustainable Cities and Society*, *38*, 582–593. https://doi.org/10.1016/j.scs.2018.01.023
166. White, M. P., Alcock, I., Wheeler, B. W., & Depledge, M. H. (2013). Would You Be Happier Living in a Greener Urban Area? A Fixed-Effects Analysis of Panel Data. *Psychological Science*, *24*(6), 920–928. https://doi.org/10.1177/0956797612464659
167. Williams, T. G., Logan, T. M., Zuo, C. T., Liberman, K. D., & Guikema, S. D. (2020). Parks and safety: A comparative study of green space access and inequity in five US cities. *Landscape and Urban Planning*, *201*, 103841. https://doi.org/10.1016/j.landurbplan.2020.103841
168. Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' *Landscape and Urban Planning*, *125*, 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017
169. Wong, S., Rush, J., Bailey, F., & Just, A. C. (2023). Accessible Green Spaces? Spatial Disparities in Residential Green Space among People with Disabilities in the United States. *Annals of the American Association of Geographers*, *113*(2), 527–548. https://doi.org/10.1080/24694452.2022.2106177
170. Wooldridge, B., & Gooden, S. (2009). The epic of social equity: Evolution, essence, and emergence. *Administrative Theory & Praxis*, *31*(2), 222–234.
171. World Health Organisation. (2017). *Urban green space interventions and health: A review of impacts and effectiveness.*
172. Yoon, D. K., Kang, J. E., & Brody, S. (2016). A measurement of community disaster resilience in Korea. *Journal of Environmental Planning and Managment*, *59*(3), 436–460.
173. Zhang, W., Gao, Y., Li, S., Liu, W., Zeng, C., Gao, L., Li, M., & Peng, C. (2022). Accessibility measurements for urban parks considering age-grouped walkers' sectorial travel behavior and built environment. *Urban Forestry & Urban Greening*, *76*, 127715. https://doi.org/10.1016/j.ufug.2022.127715
174. Zuniga-Teran, A., & Gerlak, A. (2019). A Multidisciplinary Approach to Analyzing Questions of Justice Issues in Urban Greenspace. *Sustainability*, *11*(11), 3055. https://doi.org/10.3390/su11113055