2 Engaging resilience: Integrating sociocultural dimensions into green infrastructure planning

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Abstract

Green infrastructure is recognized for its holistic approach to planning. By integrating economic, ecological and social aspects into planning policies and practices, green infrastructure provides both a conceptual framework and a practical planning tool for addressing complex, multiscale environmental problems. In addition to an interconnected, multifunctional spatial approach, green infrastructure also brings together disparate disciplines, providing a common language for dealing with contemporary challenges. Yet, despite the comprehensive approach, specific interests and expert knowledge can be privileged over others. In particular, scientific and ecological information can sideline input from local communities and residents, which is often considered subjective and difficult to measure. However, sociocultural considerations are central to green infrastructure's adaptive capacity and, thus, its ability to achieve resiliency objectives. This chapter explores how green infrastructure planning integrates differing perspectives, focusing on how citizen engagement can strengthen the role of sociocultural aspects in planning, designing and delivering adaptable and resilient cities. Typically considered non-experts, local residents have their own expertise to offer, and green infrastructure can improve how this specific knowledge informs planning policies and decisions.

Introduction - Establishing green infrastructure

Twenty years ago, green infrastructure (GI) was a relatively unheralded concept rooted in landscape ecological theory (Roe & Mell, 2013) and conservation (Seiwert & Rößler, 2020). In less than two decades, though, the concept catapulted into mainstream planning as a tool invoked across countries, metropolitan areas, industries and sectors to shape how cities are planned, designed and experienced (Hansen and Pauleit, 2014; Mell et al., 2017; Roe & Mell, 2013; Voghera & Giudice, 2019). Driven by a heightened focus on improving the environmental, economic and social resiliency of cities and regions through strengthening natural elements, green infrastructure presents myriad broadly appealing benefits (Matthews et al., 2015; Roe & Mell, 2013). Some of the benefits attributed to green infrastructure include reduced greenhouse gas emissions and climate change mitigation; enriched habitat and biodiversity; stormwater management and flood risk mitigation; improved air and water quality; enhanced access to recreation; urban cooling; improved health and wellbeing; increased property values and tourism revenue; reduced costs related to natural disasters and public infrastructure; enhanced social cohesion; and improvements in sense of place and quality of life (Benedict & McMahon, 2002; Gill et al., 2007; Kambites & Owen, 2006; Mell & Clement, 2019; Wright, 2011).

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Benedict and McMahon's early and influential definition describes green infrastructure as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations" (2002: 12). This seminal definition's simplicity and broad applicability has contributed to the concept's acceptance and adoption across varied disciplines. As laid out by Mell (Chapter 1), green infrastructure is characterized by several guiding principles: connectivity; multifunctionality; access to nature; integrated policy/practice; multidisciplinary collaboration; and an understanding of the socioeconomic and ecological benefits of effective landscape management (Mell & Clement, 2019). As such, green infrastructure refers to a range of green elements that deliver multiple benefits and that are strategically planned, managed, and connected at spatial and administrative scales (Matthews et al., 2015). Today, countries, regions and cities across the world have adopted green infrastructure policies and strategies (Calvert et al., 2018; Wright, 2011).

Green infrastructure signifies "a dramatic shift in the way local and state governments think about green space" (McMahon, 2000: 4). It achieves this by going beyond ecological-focused planning and the social and aesthetic emphasis of conventional green space planning. These planning approaches traditionally have occurred independent from each other with "separate governmental entities and policies focusing on singular issues such as recreation, water or biodiversity" (Rall et al., 2019: 264). Instead, green infrastructure reconceptualizes parks, gardens, trees, verges, sustainable urban drainage systems and other natural features as a strategic working landscape rather than as isolated, passive amenities (Whitten, 2020, 2022).

Further, green infrastructure serves as an organizing framework for connecting green elements across functional areas that previously had operated disparately, such as health, housing and highways (see, for example, the London boroughs of Camden and Islington's integration of parks and local health strategies; FOL, 2021).This has reframed green space, going beyond conventional parks (Whitten, 2022) to consider a broad definition of natural and vegetated spaces as "critical scaffolding" (Eisenman, 2013: 298) rather than as a "cosmetic afterthought" (UKDoE, 1996: iii) or "frill" (McMahon, 2000: 4). This brings urban greening in line with how urgent contemporary environmental issues, particularly climate change and biodiversity loss, are addressed through an emphasis on the interrelationship among ecological, social and economic considerations (Mell & Clement, 2019).

Through the foundational characteristics of interconnectivity and multifunctionality and its emphasis on intricately intertwined social-ecological systems (Hansen & Pauleit, 2014), green infrastructure has moved conversations "from siloed discussions of 'landscape' towards a collective, and in many cases co-produced, understanding of the environment as a multi-faceted entity that serves multiple ecological or socio-economic functions" (Mell & Clement, 2019: 9). This presents green infrastructure as having "the potential to offer win-win, or 'no regrets' solutions" (EC, 2012: 1), distinguishing it from the closely linked sustainability planning (Roe & Mell, 2013). Sustainability seeks to balance conflicting interests, yet has been criticized for perpetuating a nature-society dualism in urban planning (Talen & Brody, 2005), while green infrastructure emphasizes integration of disparate disciplinary and sectoral interests. Thus, sociocultural, ecological and economic concerns are not competing, but rather being addressed concomitantly.

Although subtle, this difference moves green infrastructure planning towards a more holistic and inclusive approach to building resilience, with the multiple functions it accommodates in aggregate producing a "synergistic effect that exceeds the sum of its individual merits" (Kim & Song, 2019: 4).

Yet, green infrastructure did not "come out of nowhere" (Thomas, 2010 cited in Wright, 2011: 1004). Rather than emerging as an entirely new concept, green infrastructure is regarded as a "hybridized concept" (Mell et al., 2017: 335) and "a melting pot for innovative planning approaches in the field of nature conservation and green space planning" (Hansen & Pauleit, 2014: 516). Indeed, green infrastructure can be considered as an evolution of planning narratives and approaches addressing a city-nature nexus, including Victorian parks (Wright, 2011), Howardian garden cities (Mell, 2008) and Olmstedian multifunctional urban landscapes (Eisenman, 2013). More recently, particularly in the U.S., green infrastructure has developed from debates surrounding stormwater management (Mell et al., 2017) and greenways planning (Seiwert & Rößler, 2020), while Rosenberg "sought to redefine the public park as an extension of urban infrastructure" (Matthews et al., 2015: 156).

Indeed, the "meteoric" (Lennon, 2015: 958) rise of green infrastructure coincides with a larger "infrastructural turn" over the past two decades that challenges the meaning of urban infrastructure (Wiig et al., 2022). Rather than narrowly conceptualizing infrastructure as hard, grey, material artefacts and systems, such as roadways and sewer lines, this infrastructural turn has connected wider networks of objects and services – including the "green and growing" (Gabrys, 2022: 14) – to the sociopolitical complexities of contemporary urban processes. In this regard, nature has become infrastructural (Gabrys, 2019; Nelson & Bigger, 2022). Fundamental to this repositioning of nature is its intersection with social systems (Hansen & Pauleit, 2014). People and communities shape and are shaped by infrastructural systems and this extends to green infrastructure. As such, sociocultural dimensions are greatly entangled with the conceptualization of green infrastructure. Further, communicative and socially inclusive planning is central to a green infrastructure approach (Hansen & Pauleit, 2014), as green infrastructure remains the result of social processes and decisions (Meerow, 2020).

A shapeshifting concept?

Despite its increasing integration into planning policy and discourse, green infrastructure remains an elusive (Hansen & Pauleit, 2014) and "carelessly used" concept (Scott & Hislop, 2019: 177). This reflects ongoing difficulties both in researching the concept (Mell, 2008), developing green infrastructure policies and in implementing green infrastructure in practice Matthews et al., 2015). Much of the academic literature continues to be preoccupied with defining what green infrastructure means (Lennon, 2015), indicating an ongoing discomfort in pinning the concept down. Mell et al. observe that "there are currently as many interpretations of green infrastructure as there are people engaging with the concept" (2017: 335). Continuing conceptual shifts enable green infrastructure to mean "different things to different people, depending on the context in which it is used" (Benedict & McMahon, 2002: 12). These contexts vary not only across disciplines, but also geographically, with "localised interpretations" emerging (Mell et al., 2017: 333). While this flexibility provides opportunities for local context, local engagement and local buy-in, a lack of definitional clarity can threaten adoption and consistent application of green infrastructure policies and practices, potentially undermining its effectiveness as a planning tool (Scott & Hislop, 2019). Thus, while the

environmental, social and economic meanings attached to green infrastructure continue to evolve (Wright, 2011), the concept's ability to take hold in policy, practice and research remains unsettled, as "new interpretations of green infrastructure are consistently being developed" (Mell et al., 2017: 336). As such, the part sociocultural attributes play in green infrastructure planning is constantly under development, as well.

Robust longitudinal studies of green infrastructure policy implementation and practical application have been slow to occur, thus evaluation has been limited to short- to medium-term impact (Mell & Clement, 2019; Willems et al., 2020). A lack of data and relevant case studies in some regions, such as sub-Saharan Africa, has limited evidence needed to integrate green infrastructure into policy and practice (du Toit et al., 2018; Lindley et al., 2018). The concept also has not had time to become embedded in planning processes in a way that ensures green infrastructure policies and practices are not simply conventional approaches with a new label or repeating unsuccessful efforts to integrate community engagement into planning processes. Indeed, green infrastructure can be delegitimized by a quickness to conflate it with green space more generally (Matthews et al., 2015).

Further, green infrastructure's attempts to shift the narrative around urban green space (McMahon, 2000) run up against powerful institutionalized amenity- and aesthetic-driven approaches to urban landscapes and green space planning (Di Marino et al., 2019; Whitten, 2020, 2022). As such, translating green infrastructure ideas and policies into mainstream planning practice, including incorporating localized sociocultural attributes, has proven challenging and is not yet supported with sufficient analysis of its effectiveness, including how sociocultural considerations are addressed (Calvert et al., 2018; van der Jagt et al., 2019). Indeed, gaps between policy rhetoric and implementation remain a challenge (Meerow, 2020), particularly between national policy and planning directives, and designing and implementing green infrastructure at the local level (Willems et al., 2020).

Further, lack of consensus around green infrastructure has been blamed on its ambiguity, leading to arguments that it is a "corruptible concept" (Wright, 2011: 1003) that can be manipulated and influenced, such as to advance political agendas (Breed et al., 2014). Claims that green infrastructure policies are adopted to green existing practices without impeding standard business practices can delegitimize green infrastructure, thus hindering efforts for meaningful application to address social and environmental challenges (Mell & Clement, 2019). As such, green infrastructure risks being a rebranding of existing neoliberal and development-centric initiatives rather than an innovative form of planning that meaningfully integrates community engagement (Matthews et al., 2015). Some policymakers and practitioners have expressed skepticism or caution about the relevance of the concept because, unlike grey infrastructure, it does not create direct financial revenue, such as taxes (Wilker et al., 2016). Difficulty directly capturing the benefits of investment in green infrastructure often leads to cuts in resources for urban greening (Wilker et al., 2016), particularly in the context of austerity politics (Mell, 2020; Whitten, 2019). Resources for engaging local communities and integrating their priorities can be particularly vulnerable to funding cuts and cost-efficiency measures. For example, community outreach officers serving as liaisons between local residents and a council's environment team were some of the first positions cut by

London councils during the recent decade of austerity in the UK. Debate has emerged regarding whether the scholarly proclivity for green infrastructure is reflected in mainstream planning practices (Di Marino et al., 2019).

However, the rush to embrace green infrastructure despite the lack of rigorous analysis of its impact may signal readiness for a "new analytical frame" to supplant long-held approaches to green space planning (Rutt & Gulsrud, 2016: 124), particularly involving disciplinary cross-pollination, administrative coordination and collaborative community engagement. Conceptual ambiguity, some maintain, has buoyed this advancement, as it allows disparate interests to use a shared language to find common ground (Kambites and Owen, 2006; Wright, 2011). Lack of rigidity in green infrastructure as a concept more widely opens the door for local context and local involvement. More deeply embedding community engagement in a green infrastructure approach also presents the opportunity to harness the public's interest in a wider range of benefits, particularly relating to sociocultural factors.

Integrating sociocultural aspects

Sociocultural attributes are at the core of green infrastructure's multifunctional approach to resiliency (Mell & Clement, 2019; Roe, 2016). Yet, similar to experiences with sustainability planning, attention on social aspects lags behind that of economic and ecological considerations in both research and policy (Dempsey et al., 2011; Chan et al., 2012). Although sociocultural values are greatly entangled with humans' relationship with the environment, these values often are overlooked or poorly integrated into green infrastructure policies and practices (du Toit et al., 2018; OPERAs, 2016). Matthews et al. refers to "a schism between nature and culture" that has emerged as efforts to delineate green infrastructure have evolved (2015: 157). Social and cultural aspects are disadvantaged, in part, because their "nebulous" (Matthews et al., 2015: 157) values and "intangible dimensions" (Chan et al., 2012: 745) are intrinsically difficult to measure and economically value (EC, 2012; Rall et al., 2019).

Different communities may have distinct connections to the environment, such as for heritage or spiritual reasons. Trees and certain animals, for example, can have cultural or heritage value for some communities (du Toit et al., 2018). Rationales for why people attach specific values to the environment, including cultural heritage, community identity, aesthetics and spiritual value, are rarely explored because they are considered "hard to capture and represent against other values" (OPERAs, 2016), causing them to be "rendered invisible" in planning (Chan et al., 2012: 745). Thus, benefits that can readily be quantified or presented in planning metrics, such as air quality, are incorporated into green infrastructure plans, while benefits from services such as recreation, inspiration, socialization and educational opportunities go unmeasured (Campbell-Arvai & Lindquist, 2021; Rall et al., 2019). The scarcity of relevant data contrasts with "the rich levels of ecological, infrastructural and statistical information usually at planners' disposal" (Rall et al., 2019: 265). Thus, sociocultural values become sidelined by more technocratic and tangible management approaches (Matthews et al., 2015). This "critical gap" results in a "partially formed" (Rall et al., 2019: 265) planning approach, with "a downplaying of or disregard for cultural services and issues of 'community' interest" (Campbell-Arvai & Lindquist, 2021: 2).

Further, expecting green infrastructure to perform numerous functions, including sociocultural ones, can be unrealistic, particularly in dense cities. This can result from

ambiguity of the concept of multifunctionality by planners (Hansen et al., 2019), as well as the oversimplified belief that green infrastructure can "have it all" (Horwood, 2011: 271) and is capable of universally satisfying demands or that "the more functions the better" (Hansen & Pauleit, 2014: 527). This suggests the various functions green infrastructure can perform are equal or can readily accommodate each other. However, in practice, conflicts arise and different functions and benefits are emphasized (Madureira & Andresen, 2014), such as between food production and flood mitigation (du Toit et al., 2018). As such, green infrastructure planning continues to refine its focus (Jerome, 2017).

Green infrastructure also is hampered by long-standing tensions that exist between planning's competing priorities, particularly between growth and conservation (Campbell, 1996, 2016). Lennon (2015) asserts that green infrastructure is simply the latest effort to address larger debates on balancing environmental concerns with development in land-use planning policy. Meanwhile, Thomas and Littlewood posit that green infrastructure is a form of "ecological modernization" that provides a means of lubricating the frictions found between economic development and environment-oriented strategies" (2010: 212). Efforts to define green infrastructure can be seen to emphasize economic benefits and, because "contested concepts are inherently political," those with more political power likely have more influence over how the concept of green infrastructure is interpreted and implemented in policy (Wright, 2011: 1010). Specifically, when held up against more powerful economic development approaches, green infrastructure is vulnerable (Mell & Clement, 2019). Indeed, Wright (2011) argues that claims that green infrastructure benefits everyone are superficial, while in practice socioeconomic interests supersede environmental ones. For example, the U.K. government has sought to address resiliency by increasing urban green spaces (MHCLG, 2019) and facilitating green infrastructure standards (DEFRA, 2018). Yet, at the same time it has allowed residential development to bypass the planning process through permitted development rights (Ferm et al., 2021) as well as proposed reforming the planning system with a focus on "build, build, build" (MHCLG 2020; UKPM, 2020). The heightened focus on the benefits of nature for health and well-being that occurred during the Covid-19 pandemic have emphasized the added socioeconomic value delivered via increased investment in nature (Mell & Whitten, 2021).

Policy tradeoffs between environmental priorities and urban development are prominent, including in the Global South (du Toit et al., 2018). Local authorities prioritize providing basic services over provision and management of green infrastructure, thus perpetuating a siloed approach. Economic interests "carry significant weight for the implementation of green infrastructure, especially in uncertain economic conditions when the state must facilitate economic growth and meet housing pressure" (Wright, 2011: 1011). Even use of the term "infrastructure" links the issue of urban greening to socioeconomic concerns, including economic development, leading Matthews et al. to conclude that green infrastructure is "essentially an economic case for greening" (2015: 157).

Further, at its core, green infrastructure planning is about land use, and the capacity to affect land-use decisions is essential for economic development, with land use integral to a city's desirability and productivity (Breed et al., 2014). Attempts to economically value green spaces and green elements, such as natural capital accounting, have become more embedded in decision making (Chan et al., 2012). This coincides with the growing

assertion that green space and ecosystem services should be reframed as an economic investment and this has led to pushing green infrastructure to focus more explicitly on economic benefits (Mell & Clement, 2019). The focus on growth and development typically comes at the expense of ecological and sociocultural benefits, thus diminishing green infrastructure's multifunctional aspirations. Indeed, traditional accounting methods typically dismiss green infrastructure's broader societal benefits, such as public health and biodiversity gains, because they are not as readily determined as costs for green space management are (Scott & Hislop, 2019). As such, "we tend to value what is measurable rather than simply measure what we value" (Scott & Hislop, 2019: 177).

While debate regarding an economic emphasis co-opting green infrastructure's multifunctional principle continues, the concept's roots in landscape ecology and conservation can result in ecological functions and services dominating green infrastructure narratives. Environmental values and functions are core to Benedict and McMahon's foundational definition, and an environmental focus is considered fundamental to securing green infrastructure's objectives (EC, 2012; Wright, 2011). Indeed, stated objectives emphasize promoting ecosystem health and resilience, contributing to biodiversity conservation and enhancing ecosystem services (EC, 2012). However, green infrastructure initiatives are criticized for narrowly focusing on ecological issues to the exclusion of multifunctionality (Lovell & Taylor, 2013). Privileging environmental aspects of green infrastructure occurs at the expense of sociocultural and political-institutional concerns (Chan et al., 2012; Matthews et al., 2015). Ecological issues are given more weight than sociocultural experiences, in part, because ecological data is more straightforwardly collected and used and can more readily be verified by planners and other practitioners (Faehnle et al., 2014).

Additionally, legislative requirements and other legal instruments can be interpreted as prioritizing environmental issues over sociocultural aspects. In Helsinki, for example, Faehnle et al. (2014) found that ecological matters were given precedence over community preferences because of environmental legislation, as well as the belief that scientific information outweighs resident experiences. This stance was strengthened by the argument that legislation requiring community input "does not specify how residents' arguments should be valued, [thus] ecological requirements tend to be stronger" (Faehnle et al., 2014: 175). Further, traditional planning practices, exacerbated by siloed thinking, often approach social and ecological processes as contradictory rather than "synergistic" forces (van de Jagt et al., 2019: 758).

Yet, sociocultural values should not be disconnected from ecological values (van de Jagt et al., 2019). The interplay between ecological and sociocultural aspects should inform green infrastructure policy development and practical implementation from the outset. In other words, green infrastructure planning should facilitate these functions interacting simultaneously and collectively adapting to change (EC, 2012; Mell, 2008). Indeed, adaptability is a structural strength of green infrastructure (Mell & Clement, 2019). The concept's intrinsic adaptability and responsiveness matters because improving the capacity of the landscape to adjust and respond to changes, such as those stemming from climate change and public health concerns, enhances long-term environmental, economic and sociocultural outcomes (Matthews et al., 2015). Green infrastructure planning accommodates changes over time because an interconnected network delivering multiple functions and services can adapt better than a fragmented patchwork of individual green spaces can. Given unknown future conditions arising from multifaceted challenges such as climate change, public health, biodiversity loss and food insecurity, green infrastructure's core principles of interconnectivity and multifunctionality, for example,

offers a valuable adaptive strategy (Lovell & Taylor, 2013). Rather than contributing to urban resiliency by merely minimizing harm to environmental systems, green infrastructure's ability to adapt gives it the ability to improve or restore natural resources.

Sociocultural considerations are fundamental to green infrastructure's capacity to respond to rapid urban change. Dynamic urban change brings a constant churn of demographics, cultural backgrounds, values, attitudes and preferences. As cities change, so do their sociocultural character, values and relationships with the environment. Green infrastructure's ability to adapt to sociocultural change is as important as its response to environmental change (OPERAs, 2016). In Yesan, South Korea, for example, a green infrastructure plan was developed to adapt to changes stemming from depopulation (Orantes et al., 2017). Connectivity of the region's ecological and sociocultural characteristics was central to the plan, which will guide Yesan's future development. In particular, planners were conscious of not prioritizing ecological assets at the expense of sociocultural ones. The result was a multifunctional green infrastructure plan that allows for "creation of areas where people can directly experience nature and acquire sensitivity about their natural surroundings and the value and services they can provide for the everyday life" (Orantes et al., 2017: 15).

The influence of competing interests on green infrastructure policy development and practical implication is reflected in an emerging geographically distinct consensus, shaped by political and cultural narratives, which influence planning traditions (Mell & Clement, 2019; Voghera & Giudice, 2019). Indeed, rather than moving towards international consensus, discourse surrounding green infrastructure is becoming more regionalized and localized, reflecting variation in national and subnational planning systems (Mell et al., 2017). This is illustrated by the differing approaches used in the United States and the United Kingdom, both of which expressed an early acceptance for green infrastructure. Whereas in the U.S., green infrastructure focuses largely on ecological principles and benefits, the U.K.'s process is rooted in a more socially inclined approach (Kambites & Owen, 2006). Similarly, in North America, emphasis is strongest on stormwater management, whereas in Europe an integrated approach to ecological and socioeconomic improvements serves as motivation (Mell & Clement, 2019). This calls into question green infrastructure's capacity for providing a comprehensive and unifying framework that accommodates competing perspectives (Matthews et al., 2015).

However, at the same time, change is heterogenous, thus geocultural characteristics vary across space and time and must be constantly revisited. For example, aging urban populations in the U.K. and Japan signal evolving demands on and connections to the landscape. To adapt, a green infrastructure approach would recognize the need to extract changing health and wellbeing benefits that landscape can provide (Roe, 2016). In addition to population and demographic changes, changes occur in information about and attitudes towards the environment, resulting in changes in values of and relationships with the environment (OPERAs, 2016). As such, community engagement is not limited to a one-time exercise, but rather green infrastructure requires on-going participation (Willems et al., 2020). Further, the relationship between people and landscape is intrinsically reciprocal, with culture simultaneously changing landscape and embodying it (Nassauer, 1995). This "mutual moulding" (Roe, 2016: 5) is constantly being recreated. Disregarding the input of local residents, particularly regarding sociocultural concerns,

can facilitate green gentrification and perpetuate the exclusion of some community members (Campbell-Arvai & Lindquist, 2021). As such, continuous engagement with local communities is critical to identifying and adapting to shifting sociocultural values and, thus, must be built into green infrastructure planning (OPERAs, 2016; Roe, 2016). Without doing so, green infrastructure's ability to realize its potential as an effective planning strategy to shape development and improve urban resiliency remains unclear (Rall et al., 2019).

Building capacity through community

Inclusion and participation "will be crucial to the success of green infrastructure" (EC, 2012: ii), and sit alongside interconnectivity and multifunctionality as guiding principles of green infrastructure (Benedict & McMahon, 2002; Hansen & Pauleit, 2014; Roe, 2016; Wilker et al.; 2016). Community input is vital for integrating how residents experience and value the local environment into green infrastructure decision making (Faehnle et al., 2014). Further, involving residents in green infrastructure planning initiatives can improve community buy-in, bolster public support and enhance the likelihood of long-term success (Campbell-Arvai & Lindquist, 2021). For example, input from urban residents regarding their perceptions and values are critical to the efficacy of green infrastructure as an adaptive response to climate change (Matthews et al., 2015). It also is recognized that community-led involvement is essential to supporting planners, designers and other landscape practitioners to develop equitable "places that are accessible, meaningful and functional for local populations" (Mell & Whitten, 2021: 13).

For these values to inform planning policy and decision making, they must be expressed and explored. Thus, a community-led, bottom-up approach to participatory planning must underpin green infrastructure policy and practice (Ferreira et al., 2020; Mell & Whitten, 2021). Approaches that are more participatory are increasing, although scope remains for local governments and other entities to more readily embrace local knowledge in green infrastructure planning (Mell & Whitten, 2021; Willems et al., 2020). As green infrastructure and its focus on resilience become more prominently embedded in planning processes, cities are prioritizing active community participation to improve green infrastructure decision making processes (Campbell-Arvai & Lindquist, 2021; Voghera & Giudice; 2019). Community-led engagement that occurs during initial stages of strategic planning and development, rather than seeking community input once decisions have been made or options narrowed, strengthens and elevates the influence sociocultural aspects have on using green infrastructure planning to build resilience.

For example, the city of Aarhus developed a master plan to guide transforming the monofunctional Gellerup housing estate – the largest social housing complex in Denmark – into a multifunctional urban area. More than 12 percent of the budget was allocated to developing urban green space (Hansen et al., 2017). With 79 percent of Gellerup's residents coming from non-Western countries, engagement in traditional participation schemes were not effective. Instead, the city turned to participatory workshops, "look-and-learn" visits and walking tours with a range of residents, including women and youth organizations to engage with residents "from the inside out" (Hansen et al., 2017: 75).

Although local governments may have responsibility for delivering green infrastructure, its design and implementation are co-produced within a network of stakeholders (Willems et al., 2020). As such, green infrastructure's adaptability is reliant on a collaborative, socially inclusive planning process that prioritizes stakeholder and

community engagement (Rall et al., 2019; van der Jagt et al., 2019). Citizen engagement can capture public attitudes and preferences regarding qualities or features of nature and urban greening to guide design and management decisions. As such, "profound levels of participation" (Willems et al., 2020: 24) are needed for green infrastructure planning, and "all groups of society should have a say in its planning and implementation to ensure that it meets their requirements" (Wilker et al., 2016: 230). Community collaboration and engagement also is needed to ensure that easily quantifiable benefits are not privileged at the expense of sociocultural benefits, such as cultural expression, valued by local residents (Campbell-Arvai & Lindquist, 2021). In particular, local and indigenous knowledge should be included in green infrastructure decisions (Ferreira et al., 2020).

Sociocultural aspects of green infrastructure planning are heavily context-dependent (Faehnle, 2014; Wilker et al, 2016) and, thus, community engagement at the local – even hyperlocal – scale is crucial for green infrastructure's success at a broader network scale (Kati & Jari, 2016). Indeed, a policy or benchmark should acknowledge that green infrastructure must "reflect and enhance the local character and priorities of the area for it to be successful" (Calvert et al., 2018: 570). For example, local residents can provide insights on "what kinds of places and routes different groups of residents find pleasant, calming, inconvenient, scary etc., which activities they appreciate, how the environment supports or hinders these activities and what kind of futures the different groups find worth striving for" (Faehnle, et al., 2014: 172). Involving local stakeholders to form a "community of practice" could strengthen and contribute "indigenous knowledge of the benefits of traditional African garden forms," critical considering gardens traditionally have served as some of the most bio-culturally diverse spaces in a city (Lindley et al., 2018: 333). In contrast to traditional top-down decision-making approaches, community-focused input can improve conditions for development of green infrastructure (Wilker et al., 2016).

While residents' values and preferences regarding the environment "is a serious issue in planning practice" (Wilker et al., 2016: 230), embedding community participation in green infrastructure planning and decision making is difficult (Ferreira et al., 2020). In part, local community involvement remains "rarely adopted" because of the belief that "multi-stakeholder initiatives slow down urban planning and policy development processes due to a lack of consensus and different sectoral interests" (Ferreira et al., 2020: 2). Seen as subjective, resident and non-expert stakeholder input is often dismissed in favor of objective or nonpolitical knowledge from professional and scientific experts and disciplinary perspectives (Faehnle et al., 2014; Mell & Clement, 2019). As such, many green infrastructure projects continue to be top-down or expert-led initiatives (Campbell-Arvai and Lindquist, 2021), fitting with larger challenges in involving local communities in decision making involving natural resources (Shandas & Messer, 2008). Local community values and input drawn from residents' experiential knowledge is challenged by the dominance of ecological information and, thus, is not recognized as relevant information in planning processes (Faehnle et al., 2014). Methods of community participation also may not fit with approaches to accessing technical experts (Shandas & Messer, 2008). As such, sociocultural concerns and needs voiced by local residents are disadvantaged compared to ecological and economic knowledge from scientists and other stakeholders (Faehnle et al., 2014). In particular, input regarding sociocultural considerations runs the risk of being a public participation tick-box exercise (Wilker et

al., 2016). For example, in an analysis of 20 European countries, Hansen et al. (2016) found that citizen participation efforts for green infrastructure planning tend to be focused on efforts to contact stakeholders rather than on ensuring stakeholders are actually engaged and their input taken into consideration. As such, "it remains unclear … whether input produced by residents is regarded as relevant in the making of influential policy choices, such as choosing which ecosystem services and benefits should be considered" (Faehnle et al., 2014: 172). Further, green infrastructure planning initiatives that marginalize communities by prioritizing expert-driven and top-down approaches miss the fundamental principles of green infrastructure, namely "the establishment of inclusive and multifunctional urban greenspaces that are sensitive to the needs of users" (Campbell-Arvai & Lindquist, 2021: 9).

Yet, the perspective "of those who live, work and enjoy themselves, suffer or invest in a place, those who manage it, argue about it, and get involved in collective action on its behalf" (Healey, 2008: 448) is essential for adapting planning, including green infrastructure planning, for sociocultural changes (Wilker, 2016). This "intimate knowledge" of local values may be "sensitive territory," but including it is vital to decision making and the legitimacy of green infrastructure planning (Chan et al., 2012: 746, 755). Local landscapes also provide "an understandable focus for community action" (Shandas & Messer, 2008: 415). Contrasting with ecological provisioning and regulating services, evaluating sociocultural attributes relies on understanding specific contexts and the cultures of local communities (Faehnle et al., 2014). Particularly in urban contexts, where green infrastructure implementation features more prominently, a disciplinary expertise-centric perspective can actually impede sustainable planning approaches (Mell & Clement, 2019). Local stakeholders' expertise, however, can advance understanding and, ultimately, the effectiveness and viability of green infrastructure efforts (Faehnle et al., 2014; Wilker et al., 2016). Community support is vital for social sustainability of green infrastructure features, but to achieve such sustained buy-in, these features must reflect the context of the local community (Campbell-Arvai & Lindquist, 2021).

As green infrastructure continues to evolve, recognition of the importance of community-scale green infrastructure sites in a multiscale green infrastructure approach has evolved. Small-scale green infrastructure planning initiatives complement projects at the strategic scale, underscoring opportunities for and contributions of active community-level engagement (Jerome, 2017). In Utrecht, The Netherlands, local residents have become actively engaged in Neighbourhood Green Plans, which provide a means for locals to contribute ideas for green space projects (Hansen et al., 2017). Feasible projects are connected and form a Green Plan, which local residents then help implement and maintain. A focus on the community scale may seem in conflict with or counterintuitive to green infrastructure's principle of taking a comprehensive approach to green space planning (Wilker et al., 2016; Rall et al., 2019), yet this is central to green infrastructure's adaptability. Economic and ecological valuations and outcomes may be more consistent across contexts, but sociocultural variation requires awareness of and sensitivity to specific situations. Failure to integrate sociocultural values through participation can result in disputes and disengagement, thus impeding green infrastructure's resiliency objectives (OPERAs, 2016). Chan et al. (2012) caution that omitting sociocultural values also can result in negative and unintended consequences that undermine a project's green infrastructure goals. As such, green infrastructure planning must ensure sociocultural values are "well-represented in techno-ecological or cost-efficiency analyses" (Kati & Jari, 2016: 544).

Indeed, just as disciplinary cross-pollination is essential for facilitating change and developing green infrastructure as a concept, community participation is needed to change institutionalized governance structures, shape debate and influence implementation of green infrastructure planning (Mell & Clement, 2019). As such, knowledge is co-produced through disciplinary expertise and non-expert stakeholder discussions regarding scientific, and social data and cultural preferences. This is dependent on "integration of non-expert stakeholders embedded in the communities of practice where green infrastructure is being implemented" (Mell & Clement, 2019: 8-9).

Community engagement also risks occurring too late in the planning process to have influence. Participatory approaches should occur in the early stages of green infrastructure planning (Shandas & Messer, 2008; Wilker et al., 2016). In particular, identifying sociocultural values through stakeholder engagement should occur before making concrete land-use or management decisions, as this improves collaboration, leads to more sustainable solutions and enhances the adaptive capacity of ecological and social systems (Kati & Jari, 2016). For example, performative participation, a practical, hands-on focus on designing and implementing green infrastructure, may be a more impactful approach to community engagement when addressing sociocultural aspects in green infrastructure planning. However, such an approach cannot be added into later phases of green infrastructure planning (Wilker et al., 2016).

While the contributions and value local green infrastructure initiatives can add to urban resiliency continue to be explored, the strategic network perspective fundamental to green infrastructure should not be sidelined. Small-scale green space and green elements have social value, but significant ecological challenges, such as dramatic loss of urban biodiversity, need larger-scale solutions that green infrastructure can facilitate. Indeed, the network perspective at a larger, landscape scale "is helping to modernize environmental policy" (Mell & Clement, 2019: 8). Localised, community projects can inspire broader efforts that are replicated throughout an urban area, enabling resilience or leading to transformation at a larger scale. And, by being engaged in decision making processes, community members can strengthen understanding of the "connection between their action and the health of the environment" (Shandas & Messer, 2008: 416). As such, planners must maintain awareness of "the importance of green infrastructure from a human perspective" while balancing and connecting small-scale, community-focused green infrastructure initiatives with the need for a larger network of green infrastructure to deliver the ecological, economic and sociocultural functions required for urban resilience (Mell & Clement, 2019).

Conclusion

Despite becoming increasingly integrated into planning narratives over the past 20 years, green infrastructure remains an evolving concept. Its uptake, however, recently has accelerated. This "meteoric" rise in policy and planning discourse has provided opportunities to move away from outdated planning approaches and instead reflect contemporary challenges and attitudes toward integrating nature into cities. Green infrastructure's principles of connectivity, multifunctionality and adaptability have advanced the concept in a period of urgency for human and ecological health. Yet, the concept also suffers from growing pains, particularly definitional fragmentation and challenges integrating subjective knowledge. There also have not been opportunities for

longitudinal impact assessments, particularly related to sociocultural aspects of green infrastructure.

GI approaches tend to see ecological and economic considerations dominate, in part because they are more readily identified and measured, with relatability across scales, contexts and jurisdictions, particularly compared to heavily contextualized social and cultural aspects. As such, sociocultural considerations have been slower to be integrated into green infrastructure planning. Yet, sociocultural issues are greatly entangled with ecological and economic functions, as well as forming a central aspect of green infrastructure planning on their own. Thus, focus is increasing on social and cultural aspects. This is facilitated by engaging local communities in participatory planning early in planning processes. Adaptability is particularly relevant, as changing urban contexts – including changing demographics, values, interests and awareness, as well as changes in the physical built environment – are reflective of sociocultural changes. To develop a responsive green infrastructure approach, engaging the community through a bottoms-up approach is central to building resilience, as well as to addressing processes of green gentrification.

Yet, research has been relatively neglectful of participatory green infrastructure planning (Willems et al., 2020). This is particularly the case for citizen engagement in later stages of green infrastructure – such as maintenance – that remain under-researched (Willems et al., 2020; Jerome et al., 2017). As green infrastructure continues to evolve and become further embedded in planning systems, more attention should be given to the sociocultural characteristics, values and experiences of residents who make up diverse communities where the impacts of green infrastructure will be felt.

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