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Adapting cities for transformative climate resilience: Lessons from the field

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Published in
Frontiers in Sustainable Cities

ISSN 1664-8714
ISBN 978-2-8325-2716-0
DOI 10.3389/978-2-8325-2716-0

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Adapting cities for transformative climate resilience: Lessons from the field

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Citation
Daniere, A. G., Archer, D., eds. (2023). *Adapting cities for transformative climate resilience: Lessons from the field*. Lausanne: Frontiers Media SA.
doi: 10.3389/978-2-8325-2716-0

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frontiers | Frontiers in Sustainable Cities

TYPE Editorial
PUBLISHED 30 May 2023
DOI 10.3389/frsc.2023.1211125

OPEN ACCESS

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RECEIVED 24 April 2023
ACCEPTED 15 May 2023
PUBLISHED 30 May 2023

CITATION
Daniere A and Archer D (2023) Editorial: Adapting cities for transformative climate resilience: lessons from the field. *Front. Sustain. Cities* 5:1211125. doi: 10.3389/frsc.2023.1211125

Editorial: Adapting cities for transformative climate resilience: lessons from the field

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KEYWORDS

urban, resilience, climate change, climate adaptation, transformation, cities

Editorial on the Research Topic
Adapting cities for transformative climate resilience: lessons from the field

Introduction

The papers in this special issue recognize that cities play a pivotal role in global climate change adaptation, particularly the many urban centers facing serious climate change impacts, such as droughts, flooding, and extreme weather. They also hold significant potential for innovative responses to the climate crisis. There is a growing consensus, however, that it is not enough for the world's cities to simply "climate proof" by protecting existing infrastructures and development plans from climate impacts. This is because, as scholars argue, the current elite-driven urbanization processes both create runaway GHG emissions and make living conditions untenable for the urban poor and other marginalized groups, even in the absence of climate change. To adapt successfully to climatic changes, urban residents and leaders need to work together to address these underlying societal crises at the same time as they design and implement programs to protect people and places from extreme conditions. This demands rethinking resilience planning and policy to move beyond protecting the status quo and toward social transformation.

The scholars whose work is featured here responded to our request for studies on how different stakeholders and their networks can engage in transformational resilience at the urban scale. These include, but are not limited to:

- Experiments with adaptive and participatory governance;
- Pro-poor 'nature-based solutions';
- Efforts to enhance urban livelihoods in the formal and informal sectors;
- Equitable and resilient strategies for housing
- Citizen science;
- Disaster risk preparedness and responses and;
- Activism and advocacy.

Providing concrete and successful examples of such endeavors from around the world is key to scaling up efforts, given the speed at which climate change is occurring. Many cities in the Global South are already struggling due to a lack of adequate resources or capacity to implement important adaptation measures. The work highlighted here responds to the need to share important and practice-based lesson on inclusive, just urban approaches to ensuring resilient urban communities.

The 11 papers included in this issue can be divided into three main categories: those that outline tools and/or planning approaches for cities to use in their search for transformative resilience; those that focus on lived experiences and resilience; and those that highlight nature-based solutions to urban resilience.

Papers outlining tools/planning approaches

Integrative resilience in action: Stories from the frontlines of climate change and the Covid-19 pandemic.

Camponeschi links "integrative resilience," which seeks to conceptualize resilience planning with notions of systemic risk and planetary health, to recent examples of community-based actions during the pandemic. Her focus is on front-line providers, and she argues that transformative resilience must include "infrastructures of care" to provide resources that enhance equity, both in times of emergency and ordinary circumstances. Camponeschi draws on examples from primary research in New York City and Copenhagen as well as from countries as diverse as Canada, Indonesia, and Brazil. Positive interventions are guided by local priorities, adopt an incremental approach to resilience that allows providers to act quickly to acute needs while drawing on a range of strategies included under the integrative resilience model.

Distributive justice and urban form adaptation to flooding risks: spatial analysis to identify Toronto's priority neighborhoods.

In their remarkable project based in some of Toronto's most marginalized neighborhoods, Mohtat and Khirfan provide persuasive evidence about how to implement an original multimodal criteria model to identify the communities within a large metropolitan region (the Greater Toronto Area) most in need of climate change adaptation. This approach can be replicated in cities throughout the globe. The authors focus on Green-Blue Infrastructure (GBI) in Toronto and demonstrate how decisions about the type and location of GBI can be improved through better designed inclusive practices.

Implementing just climate adaptation policy: an analysis of recognition, framing, and advocacy coalitions in Boston, U.S.A.

Malloy et al. apply their definition of just adaption, "a process of systematically removing institutional barriers that disproportionately burden some groups of people more than others while simultaneously creating opportunity and reducing harm related to climate change," to examples from Boston, a city where social justice is nominally a political priority. In practice, however, the authors found that reliance on technical approaches and formal frameworks prevented the actual engagement with community groups which is required to influence dynamic and transformational design and implementation of climate change efforts.

Building a vision for more effective equity indices and planning tools.

In their Perspective essay, Rosan et al. highlight their work on community-driven and locally based resilience processes designed around community needs. They echo the claims of the other scholars in this issue arguing that it is only through designing resilience initiatives with the goal of increasing equity that responding to climate change can be transformative. While their work is exploratory in nature, they have begun development of data-based, multi-scalar tool for climate adaption in Philadelphia called Planning for Resilience and Equity through Accessible Community Technology (PREACT) that holds great promise, particularly for cities in North America.

Papers outlining lived experiences and how this contributes to resilience

Readiness at what cost? Trauma, displacement and opportunism in the Florida Keys.

Shtob's original research paper delves into the trauma experienced by Hurricane Irma survivors and how it was further worsened by delays in bureaucracy relating to insurance and aid, combined with disaster-related regulation, such as revised building codes. In the longer term, residents end up more vulnerable to displacement through real estate pressures. Through interviews with residents, Shtob illustrates the challenges that households have faced and highlights reforms in disaster preparedness and planning that could mitigate the trauma of affected communities and reinforce their resilience.

People and politics: urban climate resilience in Phnom Penh, Cambodia.

The question of "resilience for whom and against what?" is considered in Asif et al.'s paper, which delves into the politics of resilience in a context of largely privatized urbanization in Phnom Penh. The three case studies considered in the paper highlight how local citizens can apply collective action to demonstrate their visions of urban resilience and challenge the current top-down resilience agenda. In this way, these communities are pushing for more inclusive cities that consider the rights of all residents.

Vulnerable spaces and unequal responses to flooding in Lagos.

Ekoh and Teron carried out in-depth interviews with 21 residents of Lagos, which demonstrate that people understand their flood vulnerabilities and how they are shaped by income, housing, tenure, and activities of landowners, and that when faced with flooding, they apply localized methods. Using rich quotes from the residents, the paper highlights how residents established Community Development Associations that address both structural and non-structural flood management, which could be scaled up with support.

Community adaptation strategies in Nairobi informal settlements: lessons from Korogocho, Nairobi-Kenya.

The community case study by Muchiri and Opiyo also highlights community-led strategies of resilience; in particular, creating climate literacy through citizen science approaches thus enabling adaptation approaches that better address specific community-level needs. These approaches can also be tailored to vulnerable populations, such as disaffected youth or victims of abuse. Sensitive local-led approaches need to be applied in conjunction with top-down climate approaches which currently prevail in Kenya.

Governance learning from collective actions for just climate adaptation in cities.

The nature of climate change requires responsive and adaptable governance, and Yazar et al. paper makes the case that "governance learning" should include learning from collective action by citizens about how to implement robust climate change action. Drawing on

two different cities, Bergen and Istanbul, the paper demonstrates that governance learning can happen through resisting, co-opting, or expanding, depending on the extent to which governance structures accept and work with vulnerable groups.

Papers embracing nature-based solutions

Implementing participatory nature-based solutions in the global South.

Wolff et al. Perspective focuses on the transformative potential of nature-based solutions (NbS), which is determined not just by the participatory approach used but how this approach can transform the project vision and ensure that NbS are integrated with local needs. Adapting a ladder of participation in community upgrading to the NbS context, the authors highlight the importance of engaging multiple stakeholders to develop integrated visions of NbS connected to local ways of understanding the environment for the process to be transformative.

Exploring the links between the use of NbS, mindshifts and transformative urban coalitions to promote climate resilience within an ongoing reurbanization process. The case of Villa 20, Buenos Aires.

Focusing on the case of the informal community of Villa 20, Hardoy et al. paper examines the implementation of an initiative to address decarbonisation alongside urban inequalities and injustice. Through a series of urban labs, participants have engaged in a process of learning-by-doing of collective planning. The implementation of NbS approaches allows for direct involvement of residents, not just in co-design but also implementation and maintenance, creating employment opportunities and building local capacities.

Conclusion

The articles in this special issue highlight that practice-based knowledge is essential to our understanding of how to achieve transformational resilience in urban settings. They offer insights into ways forward from both high income and low or middle-income settings, and common across all papers is the emphasis on participatory and inclusive approaches as central to the process.

The papers in this issue include many primarily by early-career scholars from around the world who have participated in or documented recent work in transformational climate change action. The co-editors thank the authors for their patience and their willingness to work with us to shape such a thought-provoking set of papers. And thank you to our hard-working and brilliant topic coordinators, Dr. Joanna Kocsis (Newcastle University) and Rebecca McMillan (University of Toronto) who helped pull this special issue together.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

The University of Toronto Mississauga provided the funds that allowed us to support the authors and the graduate students who assisted us with all the work involved in soliciting and editing the special issue.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

frontiers | Frontiers in Sustainable Cities

ORIGINAL RESEARCH
published: 29 June 2022
doi: 10.3389/frsc.2022.919724

Distributive Justice and Urban Form Adaptation to Flooding Risks: Spatial Analysis to Identify Toronto's Priority Neighborhoods

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Empirical evidence points out that urban form adaptation to climate-induced flooding events—through interventions in land uses and town plans (i. e., street networks, building footprints, and urban blocks)—might exacerbate vulnerabilities and exposures, engendering risk inequalities and climate injustice. We develop a multicriteria model that draws on distributive justice's interconnections with the risk drivers of social vulnerabilities, flood hazard exposures, and the adaptive capacity of urban form (through land uses and town plans). The model assesses "who" is unequally at-risk to flooding events, hence, should be prioritized in adaptation responses; "where" are the high-risk priority areas located; and "how" can urban form adaptive interventions advance climate justice in the priority areas. We test the model in Toronto, Ontario, Canada, where there are indications of increased rainfall events and disparities in social vulnerabilities. Our methodology started with surveying Toronto-based flooding experts who assigned weights to the risk drivers based on their importance. Using ArcGIS, we then mapped and overlayed the risk drivers' values in all the neighborhoods across the city based on the experts' assigned weights. Accordingly, we identified four high-risk tower communities with old infrastructure and vulnerable populations as the priority neighborhoods for adaptation interventions within the urban form. These four neighborhoods are typical of inner-city tower blocks built in the 20th century across North America, Europe, and Asia based on modern architectural ideas. Considering the lifespan of these blocks, this study calls for future studies to investigate how these types of neighborhoods can be adapted to climate change to advance climate justice.

Keywords: climate justice, urban form adaptation, distributive justice, Toronto, spatial analysis, flood risks

OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

Received: *13 April 2022*
Accepted: *02 June 2022*
Published: *29 June 2022*

Citation:
Mohtat N and Khirfan L (2022) Distributive Justice and Urban Form Adaptation to Flooding Risks: Spatial Analysis to Identify Toronto's Priority Neighborhoods. Front. Sustain. Cities 4:919724. doi: 10.3389/frsc.2022.919724

INTRODUCTION: CLIMATE CHANGE AND DOUBLE INJUSTICE IN FLOOD RISKS AND ADAPTATION

The risks to lives, livelihoods, and property from climate change-related hazards, including floods from extreme rainfall events, is not equal, ensuing from the triad of: spatially differentiated patterns of social- and climate-related vulnerabilities, exposure to hazards, and adaptive capacity where adaptive capacity refers to the ability to cope (Carter et al., 2015; Thomas and Warner, 2019). Empirical evidence shows that the urban form of socially and climatically vulnerable neighborhoods with high exposure to flooding often maintains low adaptive capacity that renders

marginalized groups unable to cope with flood hazards (Anguelovski et al., 2016; Michael et al., 2019). For instance, there is evidence that low-income neighborhoods contain a higher percentage of impervious surfaces than affluent neighborhoods due to a lack of green spaces (Bautista et al., 2015; Garcia-Lamarca et al., 2021), leading to their inadequate adaptive capacity.

These risk inequities are rooted in the uneven patterns of urban development based on economic rationales that have long prioritized infrastructure investments in high-value real estate, leading to decades of disinvestments in hazard-exposed and impoverished yet vulnerable neighborhoods (Herreros-Cantis et al., 2020). The prevalence of climate change further extended the rationales underlying inequities, hence, exacerbated vulnerabilities and exposures through land use planning (Anguelovski et al., 2016), and we argue the town plans' design, where the town plan is defined as the streets and their networks and the arrangements of the building footprints and urban blocks (Conzen, 1960). Henceforth, urban form refers to land uses and the town plan – two of the three Conzen's (1960) urban morphology components[1]. For example, when retreat is adopted as a land use adaptation measure for flood-prone areas, it often entails the forced relocation of marginalized communities to sites far away from their social networks and livelihoods, hence worsening their vulnerabilities (Henrique and Tschakert, 2019).

Despite such unequal outcomes, there is a deficit of empirical studies that propose methodologies to measure how the adaptive capacity (or adaptation) of urban form is connected to the differential vulnerabilities (i.e., different sensitivities to risks), exposures, and risk inequities (Mohtat and Khirfan, 2021). This deficit is attributed to the nascence of theoretical studies that connect urban form with adaptation and adaptive capacity in general (Dhar and Khirfan, 2017; Sharifi, 2019c), and with climate justice in particular (Mohtat and Khirfan, 2021).

To identify how adaptation interventions can be distributed to avoid flood risk inequities, hence advance climate justice, this study draws on Rawls's (1971) distributive justice, referring to the just spatial distribution of resources to maximize benefits to the disadvantaged. We operationalize Dhar and Khirfan's (2017) framework for measuring urban form's adaptive capacity to investigate the spatial distribution of adaptation interventions, hence urban form's adaptive capacity, and explore this adaptive capacity's connections to differential vulnerabilities and hazard exposures. Accordingly, we develop a multicriteria model that includes indicators and variables to identify the spatial distribution patterns of risk drivers: social vulnerabilities, flood hazard exposures, and areas with a low adaptive capacity of urban form. Our model assesses specifically "who" are unequally at-risk to flooding events, hence should be prioritized for adaptation interventions; "where" are the high-risk priority areas located; and "how" urban form adaptive interventions may advance climate justice in these priority areas.

We test this model, which can be applied in any city within Canada and beyond, in Toronto, Ontario, Canada, where there are indications of increased frequency and intensity of flood events combined with the disparities in social vulnerabilities (Feltmate and Thistlethwaite, 2012; Rincón et al., 2018). We aim to identify how social vulnerabilities, flood exposures, and adaptation interventions within the urban form are distributed in Toronto? Based on this, which neighborhoods are experiencing the highest risks of floods and need to be prioritized in adaptation? And how can we identify these priority neighborhoods?

To answer these queries, we developed a survey that asked Toronto-based flooding experts to weigh the importance of risk drivers of our multicriteria model and their associated indicators in triggering flood risks in Toronto. We then overlaid the values of the risk drivers and their indicators in ArcGIS, using the experts' assigned weights. The results reveal that flood risks are disproportionately distributed in four tower neighborhoods with old infrastructure, where low-income, racialized, and migrant populations concentrate, namely: Thorncliffe Park, Flemingdon Park, North St. James Town, and Black Creek.

FROM DIFFERENTIAL VULNERABILITIES TO CLIMATE JUSTICE IN URBAN FORM ADAPTATION TO FLOODING RISKS

Vulnerability, or people's susceptibility to being adversely affected by shocks, stresses, and hazards (Adger, 2006b; Gallopín, 2006), is not equal but differential. Differential vulnerability entails that some social groups undergo greater human, livelihood, and financial losses due to their exposure to stresses and lack of coping capacity (Suarez, 2002; Thomas et al., 2019). Evidence on differential vulnerabilities abounds globally: from the proximity of racial neighborhoods to contaminated sites and the ensuing negative impacts on the health of their residents in the USA, to the lack of low-income communities' access to potable water and sanitary services, hence, their sensitivity to droughts in the Philippines (Bautista et al., 2015; Porio et al., 2019). Differential vulnerabilities are rooted in the historical capitalist processes of urban development and their embedded domination and oppression patterns that shape inequity in the spatial distribution of urban assets (e.g., housing, land, green space, and infrastructure) and entitlements among socially different groups, whether across income, race, gender, or ethnicity, among others (Sen, 1982; Ribot, 2014; Michael et al., 2019). With the emergence of climate change as an urban crisis, the historical disinvestments in disenfranchised neighborhoods and the systematic exclusions of the disadvantaged from power structures place vulnerable groups in unsafe living conditions, exacerbating their vulnerabilities and exposures to different hazards, including flooding events (Blaikie et al., 2005; Michael et al., 2019). Additionally, efforts to mitigate climatic hazards, such as through adaptation, align with the uneven historical mechanisms of urban development, prioritizing the protection of urban economies over climate justice through selective investment in vital urban infrastructure and wealth reproduction systems (Long and Rice, 2019, 2020).

[1]The third component is the three-dimensional built form.

Flood Risks and Climate Justice Challenges

Changing precipitation rates combined with the increase in the density of urban impervious surfaces, old and overburdened drainage systems, and urban population, particularly in low-lying areas, intensify the risk of loss of lives and livelihoods and damage to properties and infrastructure from rainfall run-off and river flooding events (Faccini et al., 2018; O'donnell and Thorne, 2020; Sohn et al., 2020). Yet, individuals experience these flood risks differentially, depending on three context-specific risk drivers: social vulnerabilities, low adaptive capacity, and exposure to flooding hazards. In fact, empirical evidence indicates that social vulnerabilities are associated with inequities in flood hazard exposures and access to adaptive capacity, triggering inequities in the spatial distribution of risks across the lines of race, income, and ethnicity, among others (Suarez, 2002; Islam and Winkel, 2017; Herreros-Cantis et al., 2020).

The uneven processes of urban development have forced marginalized groups with economically precarious and socially unstable conditions to live in deteriorating settlements, prone to power outages and infrastructure failures in the face of hazards (Walker and Burningham, 2011; Graham et al., 2016). Many of these settlements are located in low real estate value and precarious sites, like low-lying areas, floodplains, and industrial zones with impervious surfaces, which increase their exposure to flooding events. The lack of land tenure rights and informality in the Global South and discriminatory policies and zoning laws based on market rules in the Global North have led, over time, to the systematic disinvestment in these vulnerable and flood-prone neighborhoods (Chakraborty et al., 2014; Borie et al., 2019; Michael et al., 2019). Among the residents of these neighborhoods are new immigrants with language and employment barriers who lack community connections and citizenship entitlements, including election rights, to influence the formal urban governance structures and local decision-makers; hence, they are often excluded from flood awareness, warning, and management programs (Donner and Rodríguez, 2008; Dodman et al., 2019; Turhan and Armiero, 2019). Additionally, the employment of these vulnerable groups in low-paying service jobs, their everyday struggles for basic needs like food, and their lack of housing ownership render them financially unable to adopt flood protective behavior, such as buying insurance and retrofitting their flimsy settlements (Anguelovski et al., 2020; Herreros-Cantis et al., 2020; Ziervogel, 2020).

With their lack of preparedness, disenfranchised and marginalized vulnerable groups are more at risk of losing life, assets, and income due to flood hazards than the affluent groups in society (Collins et al., 2018; Kim et al., 2018). In addition, they have fewer opportunities for recovery, reconstruction, and relief due to their lack of access to personal wealth and timely and adequate assistance programs such as loans and emergency services (Rufat et al., 2015; Graham et al., 2016; Thomas and Warner, 2019). Hence, their frequent experience of risks worsens their existing vulnerabilities, reproduces new ones, and reduces their capacity to cope with future hazards.

Climate Justice Challenges in Urban Form Adaptation

Climate change adaptation refers to "the process of adjustment to actual or expected climate and its effects … to moderate or avoid harm or exploit beneficial opportunities" while adaptive capacity is the ability of humans, institutions, and systems to adapt to climatic effects (IPCC, 2014, p. 5). Urban form adaptation entails physical interventions in the built environment and functions to minimize risks by improving the adaptive capacity of urban form to reduce vulnerabilities and exposures, thereby coping with, surviving, and recovering from hazards (Dhar and Khirfan, 2017). Specifically, improving the adaptive capacity of town plans and land uses can enhance urban form's flexibility to absorb unknown climatic events with uncertain patterns, such as flooding ensuing from extreme precipitations. This improved adaptive capacity can ensure that the urban form maintains its functions and structure, contributing to urban form resilience (Dhar and Khirfan, 2017; Khirfan and El-Shayeb, 2020).

Khirfan and El-Shayeb (2020) connect urban form adaptation and resilience by drawing on Meerow et al. (2016, p. 39) definition of resilience: "the ability of an urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity." Accordingly, adaptation (and adaptive capacity) is among the three pathways to resilience, along with persistence and transformation. Framing urban form adaptation under the umbrella of resilient planning has rendered resilience central to flood adaptation policies and projects to enhance the flexibility and adaptability of urban forms to increased rainfall events (Lennon, 2015; Graham et al., 2016; Shi, 2020; Shokry et al., 2020). This is evident in the shift in land use policies to integrate large-scale green projects that absorb and dissipate rainwater run-off (Anguelovski et al., 2019; Shi, 2020) and urban design interventions that incorporate resilient water-sensitive infrastructure in town plans to infiltrate, harvest, and convey rainwater (Watson and Adams, 2010; Matos Silva and Costa, 2016).

Despite its benefits for urban form adaptation to climate change-induced floods, resilient planning risks ignoring the underlying causes behind risk inequities and differences in adaptive capacity, perpetuating the historic uneven processes of urban development (Meerow et al., 2019). In particular, the application of resilience planning as a development agenda in the last decades has capitalized on branding cities as climate- and flood-adaptive sites to encourage investments by the tourism industry, real-estate developers, and the new sustainability class (Connolly, 2019; Anguelovski et al., 2020; Garcia-Lamarca et al., 2021). The exclusionary controls over the types and locations of investments can exacerbate vulnerabilities, whether through increased land values/rents and ensuing climate gentrification (Chu et al., 2017; Shi, 2020) or through the forced relocation of marginalized groups to clear space for large-scale projects (Henrique and Tschakert, 2019). Accordingly, enhancing urban form resilience through flood-adaptive land use planning and

town plan design risks excluding vulnerable neighborhoods that already lack sufficient adaptive capacity (Anguelovski et al., 2016).

THEORETICAL FRAMING: HOW TO COMBINE URBAN FORM ADAPTATION WITH DISTRIBUTIVE JUSTICE

To investigate how the adaptive capacity of urban form is connected to differential vulnerabilities and exposures to floods, and how urban form adaptation responses should be distributed to advance climate justice, the theoretical framework of this study combines Dhar and Khirfan's (2017) urban design resilient index (UDRI) the distributive justice notion.

The UDRI Framework

We draw on Dhar and Khirfan's (2017) UDRI framework to assess and compare the adaptive capacity of urban form in different urban neighborhoods to identify the disadvantaged ones whose adaptive capacity is also low. We focus on this framework because it is clear, comprehensive, and generalizable; it is also applicable to Conzen's (1960) urban form components, particularly land uses and town plans. The framework includes seven concepts that impact the resilience, hence the adaptive capacity of urban form across functional, spatial, physical, and temporal dimensions; they are harmony with nature, polyvalency, heterogeneity, connectivity, indeterminacy, latency, and modularity (refer to **Table 1** for definitions).

While Dhar and Khirfan (2017) developed their UDRI framework for measuring the resilience of urban form at the neighborhood scale, this study applies it at the urban scale – that is, for the entire city. To facilitate this, we draw on only four of the seven concepts in the UDRI, namely: harmony with nature, polyvalency, heterogeneity, and connectivity, for which we found empirical evidence of their application at the city scale (see **Table 1**). Furthermore, we add a fifth concept, flexibility, due to the numerous theoretical and empirical debates regarding its application in assessing the general resilience of urban form at the city scale (Roggema, 2014; Sharifi, 2019a; Freire and Monteiro, 2020), particularly with regards to flooding events (Sharifi, 2019c).

While Dhar and Khirfan (2017) applied their resilient concepts to all three of Conzen's (1960) urban form components (i.e., land uses, town plans, and the three-dimensional (3D) built form), we apply the five concepts only to land uses and town plans. Our reason for this is the lack of data that facilitate measuring the adaptive capacity of the 3D urban form elements to flood risks at the city scale.

Accordingly, beginning with land uses, we consider that their adaptive capacity can be enhanced through the configurational characteristics of harmony with nature, heterogeneity, and polyvalency. Land uses in harmony with nature have a minimal impact on the natural environment and can mitigate climatic hazards by strengthening ecosystem functions. One of the prevalent ways to enhance harmony with nature through land uses for adaptation to flooding is by integrating green and blue infrastructure (GBI). GBI refers to an interconnected network of natural (e.g., lakes, streams, and parks) and semi-natural ecosystems (e.g., community gardens and green roofs) that benefit humans through providing ecosystem services (Bolund and Hunhammar, 1999; Mohtat and Khirfan, 2021). GBI can mimic natural hydrological processes such as infiltration, evapotranspiration, retention, detention, and slow flow (Liu et al., 2019) that collectively promote nature-based solutions for adaptation (IPCC, 2022). Therefore, several studies have introduced GBI as a decentralized approach for managing the excess rainwater and regulating flooding, which can supplement the centralized urban drainage gray infrastructure (Abebe et al., 2018; Li et al., 2020). Heterogeneous land uses, through the variation of their types over a spatial unit, facilitate the spread and dissipation of hazards across space. For instance, urban forms that include a rich combination of land use types with different porosity (e.g., open spaces, industrial uses, green spaces, and residential uses) are better able to dissipate rainwater run-off (Cadenasso et al., 2013; Dhar and Khirfan, 2017; Zhou et al., 2017). Polyvalent land uses allow a change in functions without significant physical changes to accommodate hazards (Dhar and Khirfan, 2017). For example, recreational spaces adjacent to rivers can become spaces that temporarily accommodate floods (Macintosh, 2013).

As for town plans, we consider that their adaptive capacity increases when they are flexible and connected. Flexibility refers to the urban form's ability to integrate future changes and interventions for adaptation; hence, it bears some similarities with Dhar and Khirfan's (2017) latency and indeterminacy concepts (**Table 1**). However, the difference is that Dhar and Khirfan (2017) used latency and indeterminacy at the micro scale in relation to small spaces adjacent to streets and intersections while Sharifi (2019a,c) used flexibility to elaborate on the characteristic of adaptable urban form at the larger scale, such as urban blocks. Therefore, we replace latency and indeterminacy with flexibility. Flexibility and connectivity often go hand in hand. Flexible town plans facilitate accommodating adaptive interventions and incorporating land modification regulations. For example, integrating green spaces in fined-grained urban blocks is easier and more cost-effective than large-grained ones with little connectivity (Salat, 2017; Sharifi, 2019a,c). Connectivity enhances the town plans' permeability by increasing the contact between blocks with streets. It, therefore, accelerates access to buildings and emergency management in the advent of intense rainfall events leading to run-off flooding (Sharifi and Yamagata, 2014; Sharifi, 2019b).

Distributive Justice

Distributive justice refers to the just spatial/temporal distribution of resources to maximize benefits to the most vulnerable (Rawls, 1971; Adger, 2006a; Shi et al., 2016). Building on Rawls's (1971) liberty and maximization rules, distributive justice gives those with the greatest need the right to equal access to resources and the priority in their spatial allocation (Sen, 1992; Adger, 2006a). We draw on the distributive justice notion to identify how different the neighborhoods' urban forms are shaped in

TABLE 1 | The UDRI framework adapted from Dhar and Khirfan (2017, p. 83–84) and the concepts from this framework that this study uses.

The UDRI framework (Dhar and Khirfan, 2017)								**Evidence on how to apply concepts to:**		**The concepts used in our theoretical framework**		
Concepts	**Definitions**	**Examples**	**Urban form applications**							**Concepts**	**Urban form applications**	
			Town plans	**Land uses**	**3D built form**	**City-wide scales**	**Sources**				**Town plans**	**Land uses**
Harmony with nature	The organization of urban form to minimize impacts on the environment while strengthening natural ecosystems to absorb risks.	GBI and natural elements that can minimize urban imperviousness.	✓	✓	✓	✓	Meerow and Newell, 2017; Li et al., 2020			Harmony with nature		✓
Polyvalency	The ability of urban form to serve diverse functions during and after disasters.	Multi-purpose open spaces that can provide space for temporary shelters after a disaster.	✓	✓	✓	✓	Roggema, 2014; Sharifi, 2019a			Polyvalency		✓
Heterogeneity	The separation of urban form components to dissipate risks.	A mixture of different land cover types across a spatial unit that can spread out run-offs.	✓	✓	✓	✓	Cadenasso et al., 2013; Zhou et al., 2017			Heterogeneity		✓
Connectivity	The ability of urban form components to hierarchically be connected to facilitate emergency management	Well-connected street networks that facilitate emergency rescue.	✓	✓	✓	✓	Sharifi and Yamagata, 2014			Connectivity	✓	
Indeterminacy	Urban form organization, including determined and non-determined morphological elements, which leaves a variety of possibilities to cope with unknown functional, spatial, and environmental changes.	Vacant spaces that accidentally are created from intersections among street networks can be used to function as bioswales.	✓	✓	✓		Not found			Flexibility* (the additional concept)	✓	
Latency	Design opportunities that enable urban form to accommodate different uses to cope with uncertainty.	Adequate spaces adjacent the streets that can be used as a shelter.	✓	✓	✓		Not found					
Modularity	A modular urban form can group and control different parts, facilitating the modification of the parts affected by a shock without affecting others.	Modular-shaped housing units, which facilitate their retrofit after disasters.	✓	✓	✓		Not found					

terms of the five resilience concepts, how social vulnerabilities and exposures are distributed, hence how we can remedy flood risk inequities. Accordingly, our theoretical framework indicates that the residents of neighborhoods at a high risk of floods are most in need of adaptation, deserving to be prioritized in the decisions around adaptive urban form interventions.

Theoretical Framework

Our theoretical framework connects these disparate notions whereby the identification of high-risk neighborhoods ensues from the simultaneous presence of four flood risk drivers: (1) exposures to flooding hazards; (2) social vulnerabilities; (3) low adaptive capacity of land uses; and (4) low adaptive capacity of town plans (**Figure 1**). Drawing on our interpretation from the UDRI framework, we assess the adaptive capacity of land uses based on their degree of harmony with nature, heterogeneity, and polyvalency while evaluating the adaptive capacity of town plans in terms of their connectivity and flexibility.

METHODOLOGY

To operationalize our theoretical framework, our methodology started with developing a conceptual framework that includes indicators and variables for measuring the four flood risk drivers (hereafter, we dub this conceptual framework "the multicriteria model"). We then conducted overlay analysis in ArcGIS using the experts' assigned weights.

Conceptual Framework: Our Proposed Multicriteria Model

Several studies propose multicriteria models (MM) to identify the spatial distribution of flood risks and their drivers, hence the priority areas for adaptation responses. In most existing studies, MMs include physical factors that cause flood hazards and exposures, such as slope, elevation, rainfall, and soil types (Lin et al., 2019; Ogato et al., 2020). However, less attention is paid to the unequal spatial distribution of adaptation interventions, hence differences in the adaptive capacity of land uses and town plans across neighborhoods and their connections to differential vulnerabilities and exposures. The few empirical studies that connect urban form adaptation with differential vulnerabilities and flood exposures also consider the unequal access of vulnerable groups to GBI to identify priority areas for just adaptative interventions– see Meerow and Newell (2017) and Li et al. (2020). However, they overlook frameworks like the UDRI that take into account the configurational characteristics of resilient urban form.

Thus, we operationalized our theoretical framework to address this deficit by proposing a MM whose indicators and variables tackle the spatial distribution of four co-existing risk drivers: (1) flood hazard exposures; (2) social vulnerabilities; (3) low adaptive capacity of land uses (due to a lack of harmony with nature, heterogeneity, and polyvalency); (4) low adaptive capacity of town plans (due to a lack of flexibility and connectivity) – (see **Figure 1** and **Table 2**). Our MM, in total, includes 38 variables, which measure 15 indicators per neighborhood as the unit of analysis, whereby the City of Toronto has defined the neighborhood's boundaries since the 1990's to facilitate collecting data, planning, and analysis[2] (City of Toronto, 2019). We mapped all the variables in ArcGIS. We normalized the variables' values from zero to ten (using linear scale transformation) to make them comparable to and combinable with each other (Meerow and Newell, 2017; Lin et al., 2019; Li et al., 2020). We calculated the average of variable values to map each indicator. The following sections explain in detail each risk driver's indicators and variables and the data sources.

Exposure to Flood Hazards

To identify the exposure of each neighborhood to flood hazards, our MM proposes two indicators: "proximity to flood plains" (Chakraborty et al., 2014; Lyu et al., 2016) and "run-off coefficients" (Thompson, 2006; Meerow and Newell, 2017; Li et al., 2020). We measured the proximity to floodplains by calculating the percentage of land covered by floodplains in each neighborhood using the Floodplain Mapping Index data (TRCA, 2020b) and the Intersect Analysis tool in ArcGIS. We estimated the average Run-off coefficients for each neighborhood, using Thompson's (2006) rational method (also see Li et al., 2020). We first estimated the average area of land covered by land use categories in the rational approach, using the land use data (City of Toronto, 2020e) and the Intersect Analysis tool in ArcGIS (**Table 3**). We then multiplied the percentage values with their relevant coefficient amount to calculate the average estimated amount for each neighborhood.

Social Vulnerabilities

We adopted Chakraborty et al.'s (2014) social vulnerability index to measure the vulnerability of Canadians to floods. Chakraborty et al. (2020) developed this index's indicators and variables based on theoretical debates, policy documents, and Canadians' demographic characteristics across census tracts. They used several statistical approaches to assure the index's generalizability, validity, and replicability. Hence, it is reliable enough to represent Canadians' socioeconomic characteristics, making it an appropriate tool for measuring social vulnerabilities across Toronto in this study. Accordingly, we considered "age," "gender," "wealth," "ethnicity, race, and immigration status," "employment status," "family structure," "education," and "built-environment conditions" as social vulnerability indicators (see the full list of indicators and variables in **Table 2**). We extracted all the variable values from the Neighborhood Profiles, which the City of Toronto has built based on the 2016 census data (City of Toronto, 2019).

The Adaptive Capacity of Land Uses

As our theoretical framework indicates (**Figure 1**), when it comes to assessing the adaptive land uses, this study draws on the three indicators of "harmony with nature," "polyvalency," and "heterogeneity" (**Table 2**).

[2]The City of Toronto consists of 25 wards and 140 neighborhoods. While each ward includes a number of neighborhoods, it is essential to underscore that, in some cases, the ward boundaries do not always align with their associated neighborhoods.

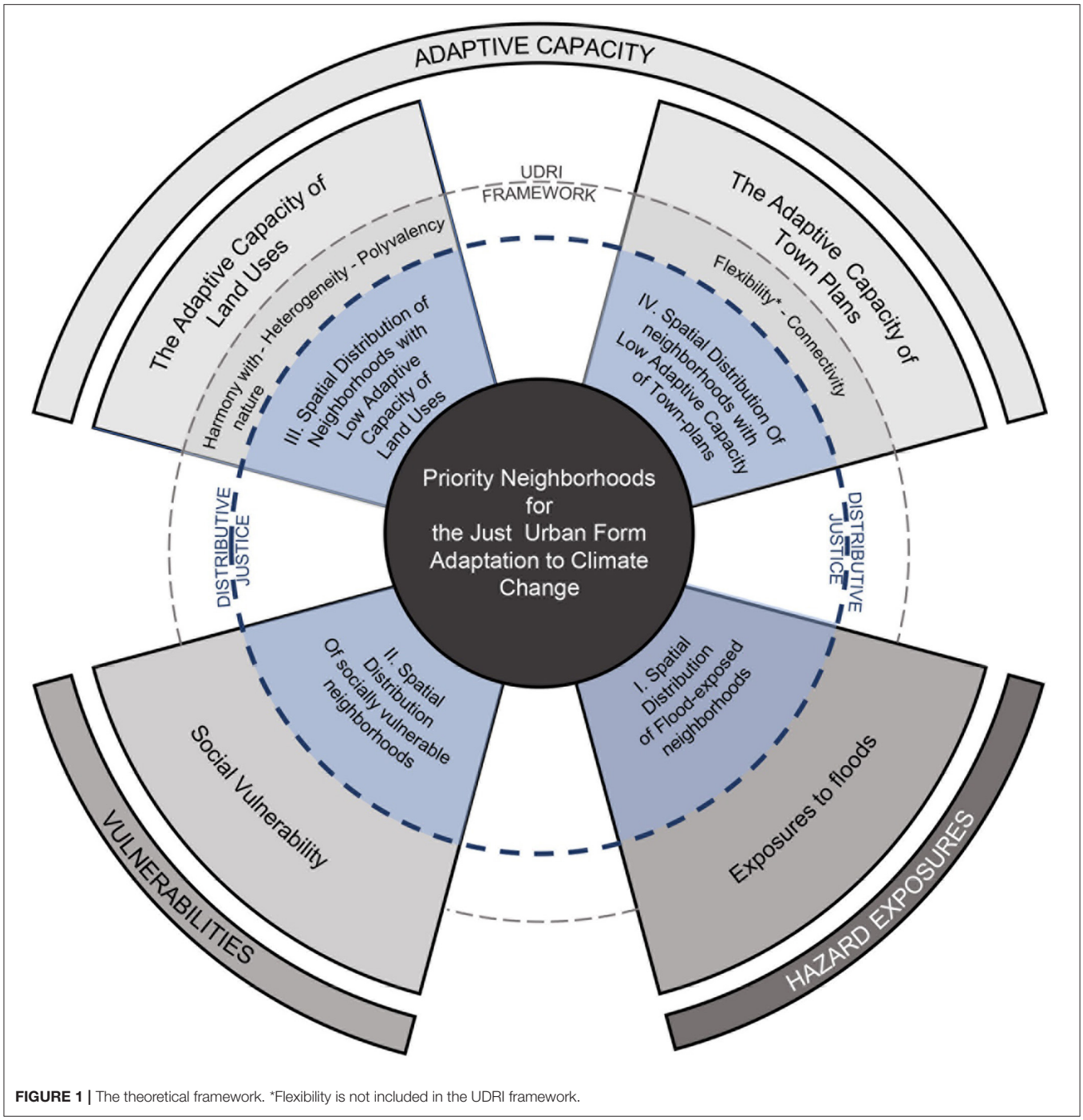

FIGURE 1 | The theoretical framework. *Flexibility is not included in the UDRI framework.

Dhar and Khirfan (2017) have proposed that the larger the amounts of land covered by natural porous surfaces, such as GBI, the higher harmony with nature of land uses. Thus, we considered the percentage of land covered by green and blue spaces and the density of street trees as variables for measuring the harmony with nature and the adaptive capacity of land uses.

To measure heterogeneity, or the spatial differentiation of land uses, we calculated the values of variables proposed by Cadenasso et al. (2013) per neighborhood. These variables include: (1) the number of land use patches; (2) patch richness, in reference to the number of different land use patches such as commercial, residential, and institutional; (3) the frequency of different patch types, referring to the number of times each land use patch appears in the urban landscape (**Table 2**). Note that the more the variables' values, the higher the urban form's ability to spread and mitigate climatic hazards like floods.

Several studies have referred to open spaces and mixed-use developments as polyvalent (or multifunctional) land uses

TABLE 2 | The multicriteria model including the major risk drivers and their associated indicators and variables.

Risk drivers	Indicators	Variables (per neighborhood)	(+) or (–) relationship with risks	Data sources
I. Exposure to flood hazards	Proximity to floodplains	The percentage of land covered by floodplains	+	TRCA, 2020b
	Run-off coefficients	The Run-off coefficients of land use categories (**Table 3**)	+	City of Toronto, 2020e
II. Social vulnerabilities	Age	The percentage of people who are 19 years old and under	+	City of Toronto, 2019
		The percentage of 65 years old and above population	+	
	Gender	The percentage of females (15 years old and above) who participate in the labor force[a]	+	
		The percentage of female people	+	
	Wealth	The percentage of the low-income population	+	
		The percentage of households spending 30% and more of their income on shelter costs	+	
		The percentage of Renter households	+	
	Ethnicity, race, and immigration status	The percentage of visible minorities[b]	+	
		The percentage of the population with the first generation[c] status	+	
		The percentage of people with aboriginal identity[d]	+	
		The percentage of recent immigrants (those who have obtained their landed immigrant or permanent resident statuses between 2011 and 2016)	+	
		The percentage of people with no knowledge of official language (English or French).	+	
	Employment status	The percentage of male people who are not in the labor force[e]	+	
		The percentage of unemployed[f] individuals	+	
	Family structure	The percentage of single-parent families	+	
		The percentage of Couple census families with three children and more	+	
		The percentage of persons living alone	+	
	Education	The percentage of people (25–64 years old) who have no certificate, diploma, or degree (including high school diploma)	+	
		The percentage of people (25–64 years old) whose highest degree is a secondary (high) school diploma or equivalency certificate.	+	
	Built-environment conditions	The percentage of households living in homes with need for major repair	+	
		The percentage of households with more than one person per room	+	
		The percentage of Labor Force (above 15) whose main mode of commute to work is public transportation[g]	+	
		The percentage of movers (people who have lived in another area and have moved here since 2015 or less)	+	
		The percentage occupied private dwellings built before the 1980's[h]	+	
		Population density	+	
III. The adaptive capacity of town plans	Flexibility	The average size of blocks	+	City of Toronto, 2020b

(Continued)

TABLE 2 | Continued

Risk drivers	Indicators	Variables (per neighborhood)		(+) or (–) relationship with risks	Data sources
		The average size of building footprints		+	City of Toronto, 2020a
	Connectivity	The average density of street networks' intersections		–	City of Toronto, 2020b
IV. The adaptive capacity of land uses	Harmony with nature	The percentage of land allocated to green spaces		–	City of Toronto, 2020e
		and blue spaces		–	
		The density of street trees per square meter		–	
	Polyvalency	The percentage of land covered by open spaces		–	
		The percentage of land covered by mixed land uses		–	
	The heterogeneity of land uses	Total number of land use patches		–	
		The number of different patches (patch richness)		–	
		The average frequency of different patch types	The number of Commercial patches	–	
			The number of Commercial Residential patches	–	
			The number of Commercial Residential Employment patches	–	
			The number of Residential patches	–	
			The number of Open Space patches	–	
			The number of Institutional patches	–	
			The number of Employment Industrial patches	–	
			The number of Utility and Transportation patches	–	

**Flexibility is the additional fifth concept of our theoretical framework.*

[a] Structural gender inequality causes female workers to suffer more than their male counterparts from unstable working conditions and low income (Kalev and Deutsch, 2018), reducing their access to assets to cope with risks.

[b] Visible minority refers to "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in color" (Chakraborty et al., 2020, p. 4).

[c] First generation refers to "persons born outside Canada. For the most part, these are now, or once were, immigrants to Canada" (Chakraborty et al., 2020, p. 4).

[d] Aboriginal identity relates to "persons who are First Nations (North American Indian), Métis or Inuk (Inuit) or those who are Registered or Treaty Indians or those who have membership in a First Nation or Indian band" (Chakraborty et al., 2020, p. 4).

[e] Male not in the labor force refers to male persons "who are unwilling or unable to offer or supply labor services under conditions existing in their labor markets (including persons who were full-time students currently attending school)" (Statistics Canada, 2008). Many cultures consider males as the main persons who financially support families. Therefore, this variable can indicate the unfavorable financial condition of households, which reduces their access to adaptive resources.

[f] Unemployed persons are those "without work, are available for work and are actively seeking work" (Statistics Canada, 2008).

[g] Flooding events can damage public transportation infrastructure (such as subways), leading to the closure of public transit systems and delays (Nirupama et al., 2014) and adversely affecting those who depend on them.

[h] The Canadian building codes before the 1980's were not strict enough to include emergency conditions (Archer, 2003).

that can accommodate floods and provide space for erecting emergency shelters (Macintosh, 2013; Roggema, 2014; Sharifi, 2019a). Therefore, we considered the percentages of areas covered by these land use types per neighborhood as variables to measure polyvalency.

For all the indicators, we used the Zoning By-Law data provided by the City of Toronto (2020e). We used the Intersect Analysis and Summary Statistics tools in ArcGIS to map all the indicators. In addition, the Dissolve and Merge tools in ArcGIS were used for analyzing the third indicator.

The Adaptive Capacity of Town Plans

Building on our theoretical framework, we draw on two indicators of "flexibility" and "connectivity" (**Table 2**) to measure the adaptive capacity of town plans.

TABLE 3 | The run-off coefficients (Thompson, 2006; Li et al., 2020).

Land use categories	Coefficient
Utility and transportation	0.85
Industrial	0.8
Multi-family and apartment residential	0.65
Commercial	0.6
Institutional	0.6
Single family residential	0.4
Open spaces	0.2

Salat (2017) and Sharifi (2019c) proposed that fine-grained blocks and building footprints are more flexible than large-grained blocks to accommodate changes, such as through small-scale adaptive interventions for incremental adaptation at a lower cost. Furthermore, they can accelerate emergency responses in the advent of flooding disasters by providing opportunities for multi-use developments and enhancing access points at street edges. Thus, we compared the flexibility of town plans in different neighborhoods by calculating the average size of their blocks and building footprints, whereby the smaller the size, the higher the flexibility.

Sharifi and Yamagata (2014), Feliciotti et al. (2016), and Dhar and Khirfan (2017) argued that the connectivity of town plans promotes the accessibility of blocks and buildings through street networks, thus facilitating evacuation planning, emergency search, and rescue activities in the advent of flooding disasters. As Feliciotti et al. (2016) proposed, the higher the number of three- and four-way intersections, the higher the connectivity. Therefore, we used the average density of street networks' intersections per neighborhood as the variable for measuring the connectivity of town plans; in other words, the higher the density, the higher the connectivity.

For both indicators, we used the data provided by the City of Toronto (2020b,d). Furthermore, we used ArcGIS for the Intersect Analysis and Summary Statistics tools to produce the indicators' maps (**Table 2**).

Weighted Overlay Analysis Through ArcGIS

Since risks result from intersections among multiple drivers with unequal importance, the existing GIS-based multicriteria approaches on flood risk mapping often involve weighted overlay analysis. Qualitative and mixed-method research studies like this one often use experts' judgments for weightings, such as through different approaches of rating and ranking – see: Meerow and Newell (2017), Rincón et al. (2018), Li et al. (2020). This weighting approach facilitates quantifying immeasurable data and responds to the challenges of data scarcity (Wang et al., 2011; Lin et al., 2019).

For this study, we conducted an online survey (using Qualtrics) to seek the experts' opinions regarding the weights of flood risk drivers (**Figure 1**) and their associated indicators (**Table 2**). Our survey population comprised Toronto-based planning experts who have experience in at least one of the fields of urban flood management, climate change adaptation, and/or adaptive urban form. We found these experts through a systematic search on Google, LinkedIn, and LinkedIn Premium. Our search yielded 392 relevant experts, working variously in four academic, 13 non-governmental, 27 governmental, and 44 private organizations. We shared the survey link with these experts through email and/or LinkedIn messaging from April to the end of June 2021. The survey eventually yielded 120 responses (31% response rate).

To ask the survey participants to weigh the flood risk drivers, we drew on the Analytic Hierarchy Process (AHP), which is a rational, accurate, cost-effective, and easy-to-use approach for measuring the importance of immeasurable elements through pair-wise comparisons (Lin et al., 2019). First proposed by Saaty (1990) for quantifying the weights of decision criteria, AHP became a popular approach for subjective evaluation of flood risk drivers in GIS overlay analysis – (see: Lin et al., 2019; Li et al., 2020; Ogato et al., 2020). Building on this approach, we asked the expert participants to pair-wisely compare the relative importance of the four risk drivers regarding the exacerbation of flood risks in Toronto with a scale that ranges from 1 (equal importance) to 9 (extremely more important) – see Saaty (1990) and **Figure 2**.

To interpret the data, we created a pair-wise comparison matrix (i.e., [**C**]) for each participant based on the fundamental AHP scale suggested by Saaty (1990):

$$[\mathbf{C}] = \begin{bmatrix} 1 & c_{12} & c_{13} & c_{14} \\ c_{21} & 1 & c_{23} & c_{24} \\ c_{31} & c_{32} & 1 & c_{34} \\ c_{41} & c_{42} & c_{43} & 1 \end{bmatrix}; \quad c_{ij}c_{ji} = 1 \tag{1}$$

where c_{ij} represents the scale preferred by participants for the importance of concept i over the concept j. We then divided the components of the pair-wise comparison matrix [**C**] by the summation of each column to calculate the normalized matrix [**M**]:

$$[\mathbf{M}] = m_{ij} = \frac{c_{ij}}{\sum_{k=1}^{4} c_{kj}} \tag{2}$$

where m_{ij} is the component of the normalized matrix. We eventually obtained the weight of the i^{th} concept ($1 \leq i \leq 4$) as the average of each row in the normalized matrix:

$$W_i = \frac{1}{4}\sum_{j=1}^{4} m_{ij} \tag{3}$$

To evaluate the consistency of the survey responses, we calculated the Consistency Index as follows:

$$C.I. = \frac{\lambda_{\max} - n}{n - 1} \tag{4}$$

where $\lambda_{\max}$ is the maximum eigen value of the pair-wise comparison matrix [**C**] and n is the number of concepts that are compared (i.e., $n = 4$). According to Saaty (1990), a consistent matrix has a Consistency Index of <10% of the Consistency

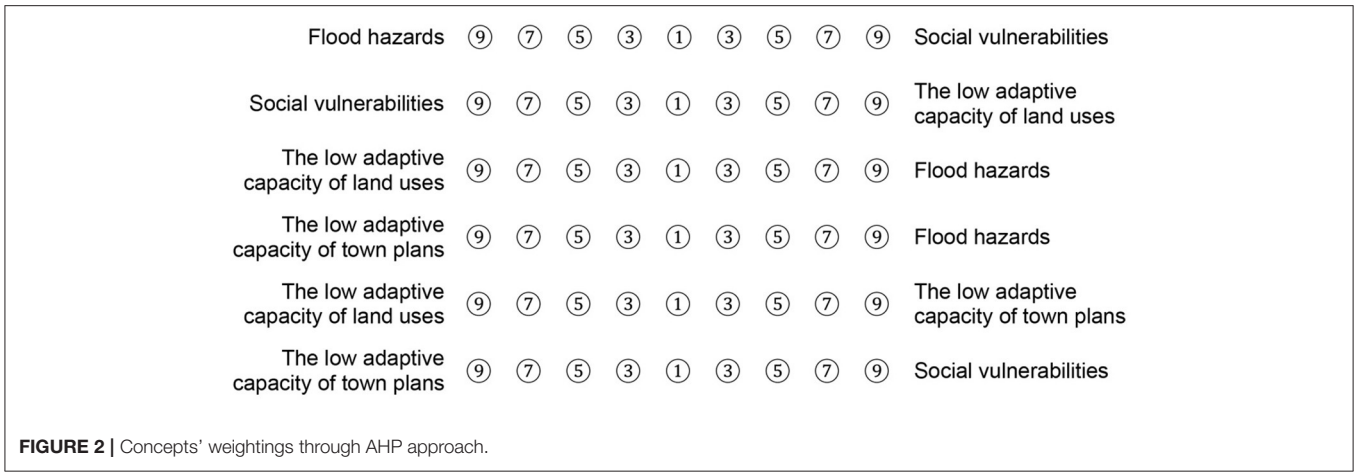

FIGURE 2 | Concepts' weightings through AHP approach.

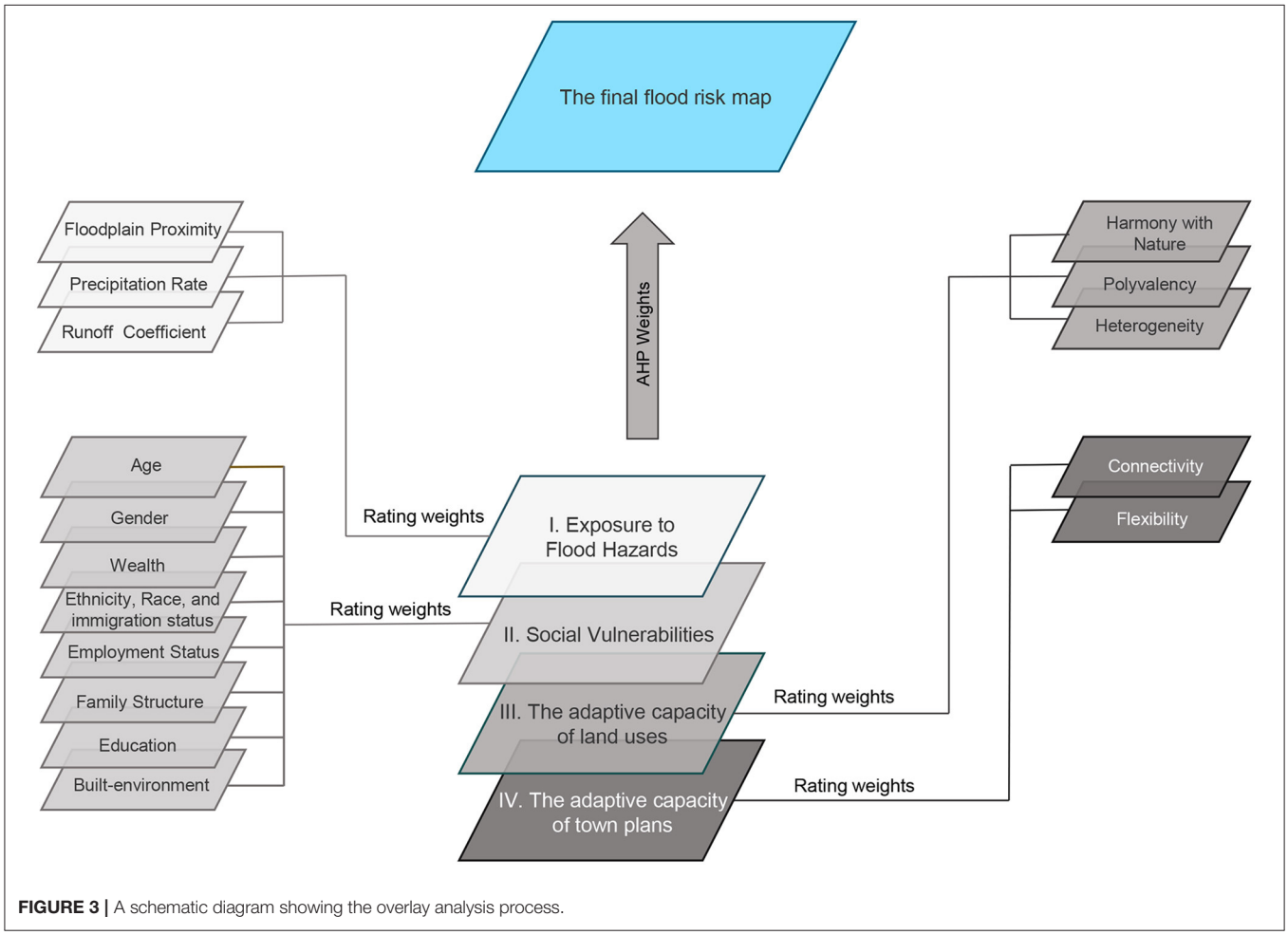

FIGURE 3 | A schematic diagram showing the overlay analysis process.

Ratio (*C.R.*); where the value of the *C.R.* for a matrix with the size of four is proposed to be 0.9 by Saaty (1990). Considering these consistency criteria, we filtered the responses and calculated the weight of concepts corresponding to each participant. The final weights of concepts are the average of weights obtained for each participant.

While AHP approach is reliable for weighting the four risk drivers, it may become a lengthy task for weighting the 16 indicators due to a large number of pair-wise comparisons (Li et al., 2020). Accordingly, we measured the weights of indicators through direct rating (DR) where expert participants assigned a weight (from 0 to 10) to the impact of indicators on each risk

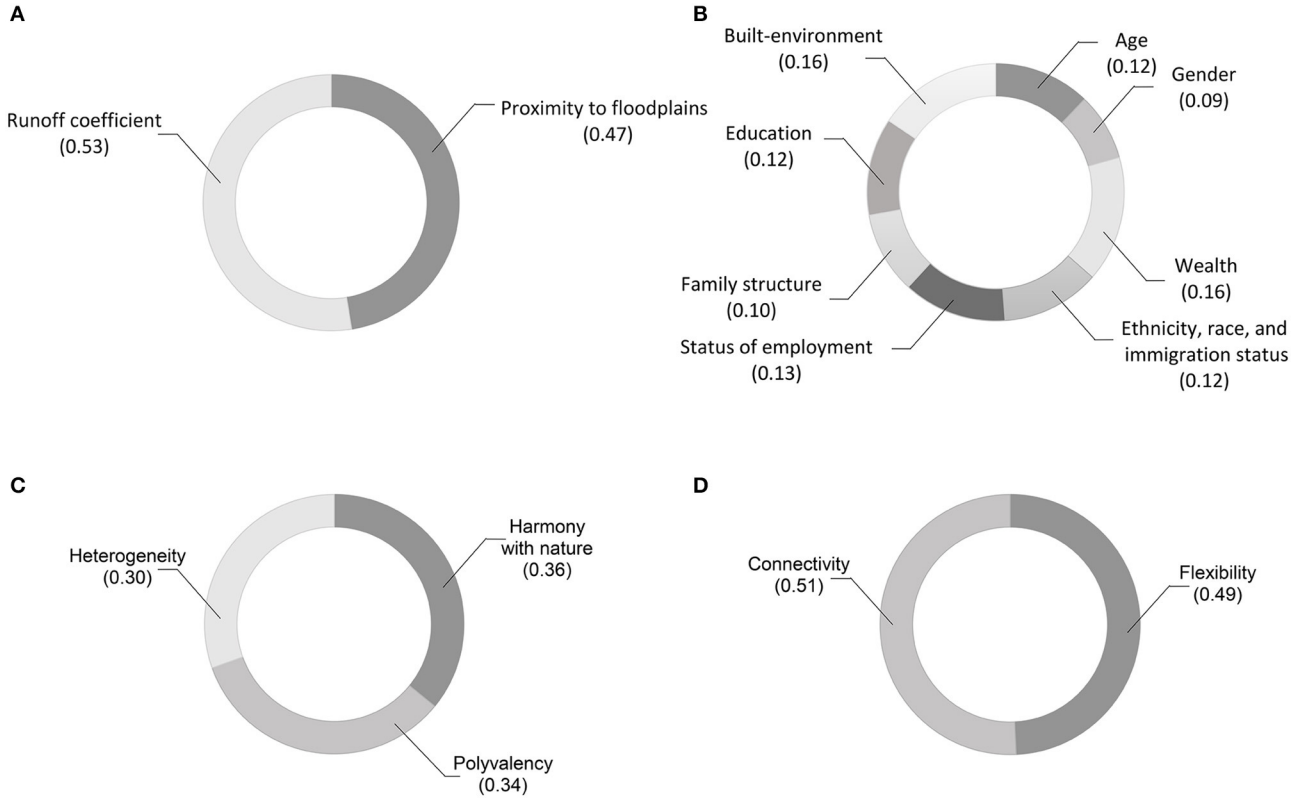

FIGURE 4 | The average weights of risk drivers' indicators. **(A)** The average weights of flood exposure indicators. **(B)** The average weights of vulnerability indicators. **(C)** The average weights of indicators associated with the adaptive capacity of land uses. **(D)** The average weights of indicators associated with the adaptive capacity of town plans.

driver – (see Bottomley and Doyle, 2001; Yang et al., 2011) on DR. The final weight of each indicator is the average of weights assigned by all the participants.

Using the weights assigned by the experts, we began our overlay analysis in two steps: overlaying the indicator maps to map their associated concepts and overlaying the risk drivers' maps to draw the final flood risk map. We used the Union Analysis tool and the weighted sum average function in ArcGIS to complete the weighted overlay analysis for both steps. Note that we normalized all the concepts and the final risk map values from 0 to 10, using linear scale transformation (see **Figure 3**).

THE CASE STUDY: TORONTO

Toronto is Ontario's capital and Canada's foremost economic hub. Toronto spreads over 633.5 km^2, and its population totals 2.73 million (in 2016), 50% of which are visible minorities, which makes it the most populous city in Canada and one of the most multicultural cities in the world (Filion et al., 2015; Statistics, 2017). The city's location within the Lake Ontario Watershed and its exposure to moist air masses and high precipitation rates have caused several historical flooding events that caused a loss of lives and damages to properties and infrastructure in 1878, 1954 (after Hurricane Hazel), 1976, 2005, and 2013 (Nirupama et al., 2014; Rincón et al., 2018; TRCA, 2021).

More importantly, there is evidence of increased precipitation rates due to global climate change in this city. Feltmate and Thistlethwaite (2012) mentioned that six 50-year and two 10-year precipitation events had been recorded during just 15 years – from 1996 to 2011. Over the last decade, governmental, non-governmental, academic, and private organizations at the different municipal, regional, and provincial levels have developed stormwater management plans, policies, and/or strategies to promote climate change adaptation (Henstra et al., 2020).

In Toronto, the City's Water Division oversees developing policies and implementing strategies for stormwater management and climate change adaptation. After the approval of the Climate Change Action Plan in 2007, the City of Toronto published its first climate adaptation strategies, including actions on flood protection and emergency management, in a document titled "Ahead of the Storm: Preparing Toronto for Climate Change" (City of Toronto, 2008). Following this document, the City continued to work on its first Resilience Strategy, which includes 50 major plans, such as the Basement Flooding Protection Program and Wet Weather Flow Master Plan and Management Guidelines (City of Toronto, 2017, 2020c).

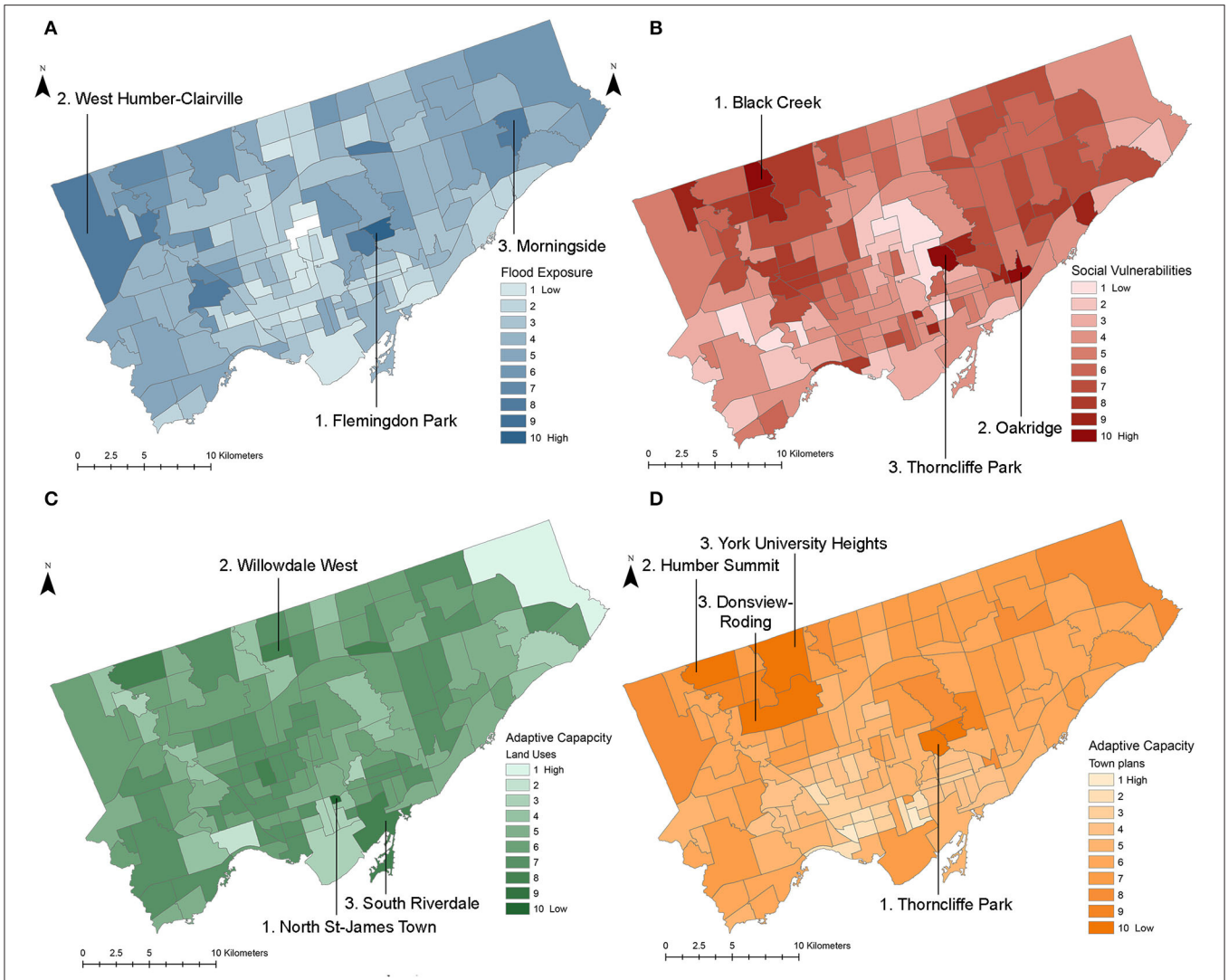

FIGURE 5 | The spatial distribution of the four risk drivers. **(A)** The spatial distribution of flood hazard exposures across the neighborhoods. **(B)** The spatial distribution of social vulnerabilities across the neighborhoods. **(C)** The spatial distribution of neighborhoods with a low adaptive capacity of land uses. **(D)** The spatial distribution of neighborhoods with a low adaptive capacity of town plans.

The City of Toronto collaborates with other organizations as well. Vertically, it works with regional and provincial governmental organizations such as the Toronto and Region Conservation Authority (TRCA). Being one of the 36 conservation authorities in Ontario, the TRCA receives funds from municipalities to offer them information on flood mapping, educational workshops, awareness programs, and low impact development (LID) design guidelines (TRCA and CVC, 2010; Henstra and Thistlethwaite, 2017; TRCA, 2020a,b). At the provincial level, the City receives advice from the Ministry of Environment, Conservation, and Parks (MECP) and the Ministry of Environment and Climate Change (MECC), among others (City of Toronto, 2020c; Henstra et al., 2020). Horizontally, non-governmental organizations (e.g., Toronto Environmental Alliance), private firms (e.g., Metrolinx), and academic institutions (e.g., Intact Center for Climate Change Adaptation) assist the City of Toronto in conducting feasibility assessment projects and developing strategies and standards (Mah et al., 2018; Metrolinx, 2018; City of Toronto, 2020c).

RESULTS: HOW ARE FLOOD RISKS DISTRIBUTED?

Mapping the Risk Drivers

Exposure to Flood Hazards

In terms of exposure to flood hazards, the survey results show that the average weights of proximity to flood plains and run-off coefficients are 0.47 and 0.53 (**Figure 4A**). Accordingly, experts believe that the run-off coefficient has a slightly higher impact on exposure to flood hazards in Toronto than proximity to flood plains. When we overlay the indicator values in ArcGIS,

TABLE 4 | The list of neighborhoods with the worst conditions in terms of each risk driver.

	Neighborhoods with the worst conditions		
	Ranks	**Names**	**Values (see the legends in Figure 5)**
(A) Exposure to flood hazards	1	Flemingdon park	10.0
	2	West Humber-Clairville	7.8
	3	Morningside	7.7
(B) Social vulnerabilities	1	Black Creek	10.0
	2	Oakeridge	9.8
	3	Thorncliffe Park	9.6
(C) Adaptive capacity of land uses	1	North St. James Town	10
	2	Willowdale West	7.5
	3	South Riverdale	7.2
(D) The Adaptive capacity of town plans	1	Thorncliffe Park	10
	2	Humber summit	9.6
	3	York University heights	9.3
	3	Downsview-Roding	9.3

using their assigned weights, the results show that Flemingdon Park neighborhood, followed by West Humber-Clairville, and Morningside, are the most exposed to flood hazards (**Figure 5A** and **Table 4**).

Social Vulnerabilities

With regards to social vulnerabilities, the survey results show that wealth and built-environmental conditions (weighted at 0.16 each) have the greatest impact on social vulnerabilities, while gender (weighted 0.09) is the least impactful (**Figure 4B**). In addition, the overlay analysis of indicators' values by using their weights shows the disproportionate spatial distribution of social vulnerabilities within the city. In this respect, Black Creek neighborhood followed by Oakridge and Thorncliffe Park have the highest social vulnerability to floods (**Figure 5B** and **Table 4**).

The Adaptive Capacity of Land Uses

When it comes to the adaptive capacity of land uses, the survey results reveal that harmony with nature followed by polyvalency (weighted 0.36 and 0.34, respectively) have the highest impacts. In contrast, heterogeneity (weighted 0.30) maintains the minimum impact on land uses (**Figure 4C**). After overlaying these indicators' values (using their assigned weights), the results show that land uses in the North St. James Town neighborhood followed by Willowdale West and South Riverdale have the lowest adaptive capacity (**Figure 5C** and **Table 4**).

The Adaptive Capacity of Town Plans

Last, with regards to the adaptive capacity of the town plans, the survey results reveal that flexibility and connectivity (weighted 0.49 and 0.51, respectively) have relatively similar impacts on the adaptive capacity of town plans (**Figure 4D**). The results of our weighted overlay analysis using ArcGIS show variation among Toronto's neighborhoods in terms of the adaptive capacity of their town plans. As shown in **Figure 5D** and **Table 4**, Thorncliffe Park followed by Humber Summit, York University Heights, and Downsview-Roding have the lowest adaptive capacity in their town plans.

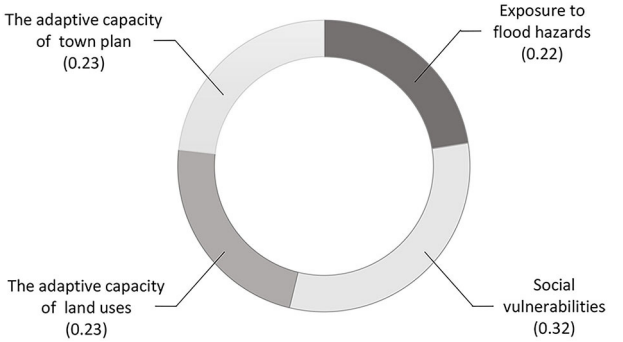

FIGURE 6 | The average weights of risk drivers, assigned by experts.

Mapping the Final Flood Risk Map: Identifying the Priority Neighborhoods

To map the final flood risk map and to identify which of Toronto's neighborhoods should be prioritized for adaptation interventions, we overlaid the maps of risk drivers (**Figure 5**) using the weights assigned by the experts. As the experts' survey results show (**Figure 6**), social vulnerabilities (0.32) have the highest impact on flood risks in Toronto, while exposure to floods (0.22) has the lowest impact. In addition, the experts believe that the adaptive capacity of land uses (0.23) and town plans (0.23) have similar impacts on flood risks. The results of the weighted overlay analysis reveal that Thorncliffe Park followed by Flemingdon Park, North St. James Town, and Black Creek are four neighborhoods that are disproportionately at risk from flooding, hence, must be prioritized in urban form adaptation interventions (**Figure 7** and **Table 5**).

DISCUSSION: DELVING DEEPER INTO THE PRIORITY NEIGHBORHOODS

Our results show that social vulnerabilities, flood hazard exposures, and urban form adaptive interventions are distributed unequally within the City of Toronto, imposing disproportionate flood risks on three disenfranchised neighborhoods: Thorncliffe Park, Flemingdon Park, North St. James Town, and Black Creek. These four neighborhoods are high-density tower communities with aging infrastructure. They were built based on Le Corbusier's tower in the park concept during the 1950's and 1960's in response to the housing boom after the Second World War. Over time, the working middle-class's disinterest in occupying these towers turned them into "ethnic enclaves" for low-income immigrant families. Often, several families can be found living communally in one unit. The increase of population density in these towers led to disinvestments in their repair and maintenance, leading to dilapidated apartment units and amenities (E.R.A. Architects University of Toronto,

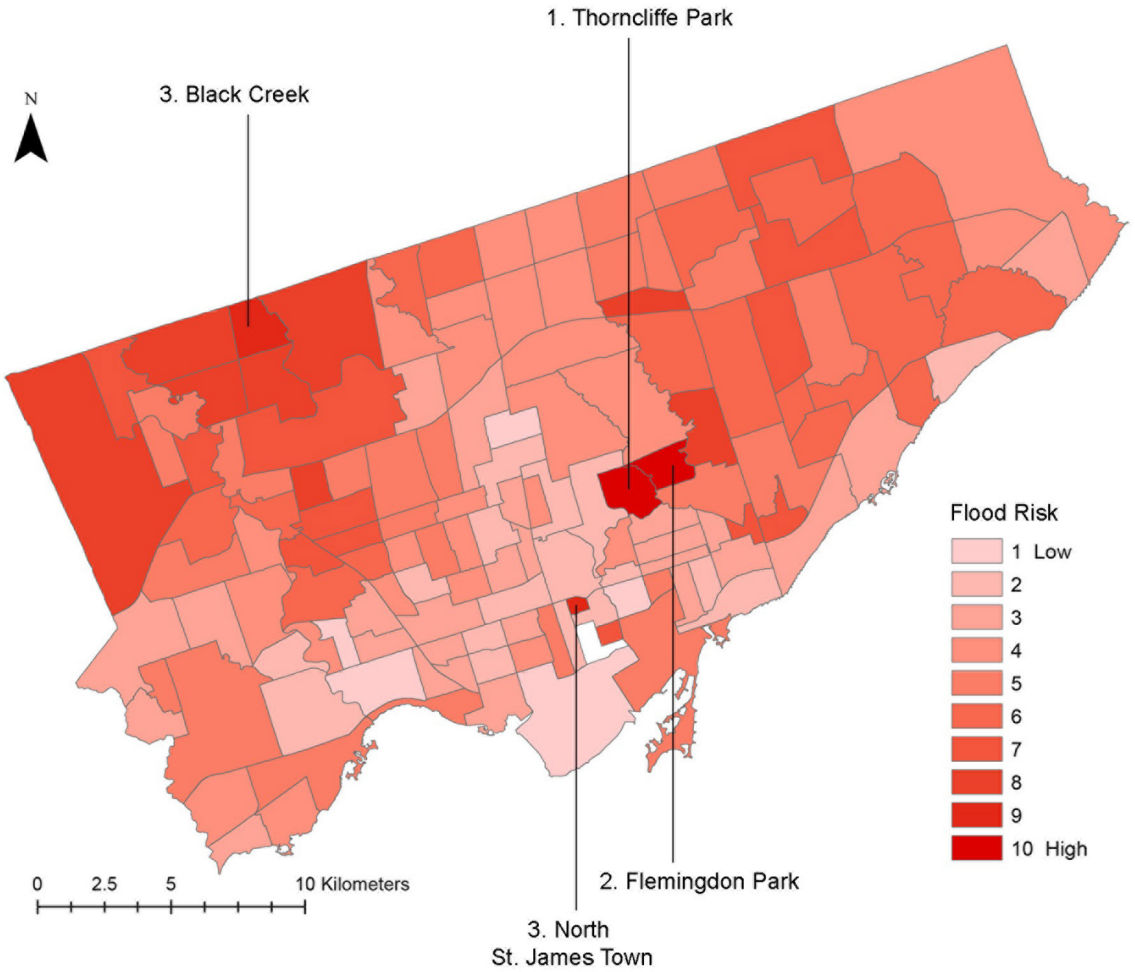

FIGURE 7 | The spatial distribution of flood risks and the priority neighborhoods for urban form adaptation in Toronto (the values are normalized from 1 to 10 when 1 shows low risks and 10 shows high risks).

TABLE 5 | The priority neighborhoods and their normalized risk value.

	The priority neighborhoods		
	Ranks	**Names**	**Values (see the legend in Figure 7)**
The flood risk map	1	Thorncliffe Park	10.0
	2	Flemingdon Park	9.4
	3	North St. James Town	8.2
	3	Black Creek	8.2

2008; Hassen, 2021). The unfavorable conditions of the built environment, the concentration of poverty, and the impervious surface materials with high run-off coefficients are the main reasons behind the vulnerability to increased precipitation and exposure to increased flooding (**Figure 8**).

More importantly, our analysis of indicator values in **Figure 8** shows inadequate adaptive capacities of these neighborhoods' land uses and town plans. The high-rise developments and the separation of land uses have resulted in a lack of land-use heterogeneity as well as urban form's large-grained blocks and disconnected streets (**Figure 8**). Although the "towers in the park" urban form includes ample open green spaces, other factors reduce the urban form's flexibility to incorporate future changes and its ability to spread run-offs. This is due to the discriminatory policies, lack of maintenance, and, more recently, infill development that have decreased and continue to reduce the quantity and quality of open green spaces and the land uses' harmony with nature. For example, North St. James Town has the lowest area of green space per person in Toronto since new apartment complexes have replaced open green spaces between the towers over time (Nguyen, 2014; Hassen, 2021) – (see **Figure 9**). Additionally, in Thorncliffe Park, Metrolinx[3] plans to replace some open spaces

[3]Metrolinx is a Government of Ontario's agency, which integrates and manages all transportation modes in the Greater Toronto and Hamilton areas (Metrolinx, 2022).

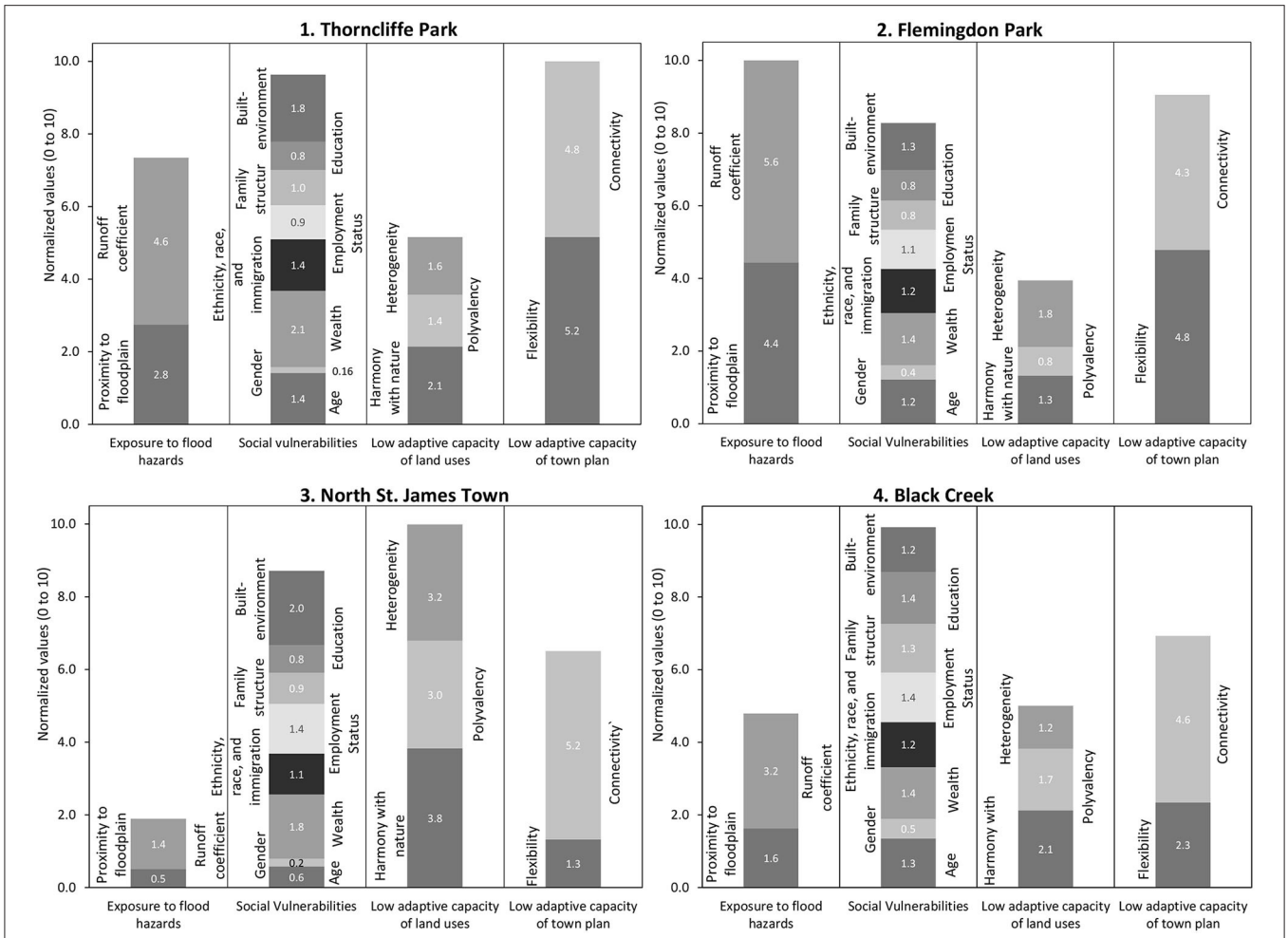

FIGURE 8 | The values of risk drivers and their indicators in the three priority neighborhoods.

and business buildings with the train yards of the Ontario Line (Aecom Canada Ltd., 2021). These plans have raised the concerns of grassroots environmental justice activists (Savetpark Community, 2021).

Yet, social vulnerabilities remain the most critical in triggering flood risks, particularly the lack of access to wealth when combined with unfavorable built-environmental conditions (**Figure 6**). Similarly, the run-off coefficient and harmony with nature are the most important indicators of flood exposure and adaptive capacity (**Figure 4**). Accordingly, we call for future theoretical and empirical studies to investigate how GBI interventions and nature-based solutions can address the root causes of vulnerability in tower communities in Toronto and elsewhere while advancing just adaptation to flooding. Furthermore, we propose that future research explores how low-income and disadvantaged communities and marginalized groups can participate and integrate their needs in the design and implementation of small-scale GBI in a way that curbs, if not altogether avoids, gentrification by maintaining housing affordability.

More importantly, our findings show that the need to prioritize tower communities for just adaptation to changing climate may not be specific to Toronto but applies globally. As they age and dilapidate over time, tower buildings that once were modern 20th century housing types have become the 21st century's affordable housing enclaves for low-income, marginalized, and vulnerable communities, particularly in Western Europe and North America. Over the last two decades, municipalities around the world have proposed strategies to advance social equity and to improve the conditions of the built-environment in similar tower buildings, whether through renovations, public realm improvements, mixed-use developments, and/or the integration of urban agriculture (E.R.A. Architects University of Toronto, 2008; Benko et al., 2018; Veschambre, 2018). Some of these improvements include climate mitigation strategies (i.e., decreasing greenhouse gas emissions through improved energy efficiency) (Aragon et al., 2018; Seebauer et al., 2019). Yet, there is a need for studies that inform both research and policy on the adaptation of tower neighborhoods to climatic

FIGURE 9 | Infill development (the displacement of open spaces with new constructions) in the North St. James Town. Blue highlights show the new developments (photo credit: Luna Khirfan).

events including flooding through participatory processes that are grounded in context-specific needs and the local communities' lived experiences as well as the knowledge of local experts.

CONCLUSION

This study proposed a multicriteria model whose variables and indicators assess the spatial distribution of social vulnerabilities, flood hazard exposure, and urban form's adaptive capacity to facilitate an assessment of "who" are unequally at-risk to flooding events, hence, should be prioritized in adaptation interventions; "where" are the high-risk priority areas located; and "how" urban form adaptive interventions may advance climate justice in these locations. Specifically, this model changes how risk inequalities are understood by combing sociodemographic indicators with five configurational characteristics of resilient and adaptive land uses and town plans: harmony with nature, heterogeneity, polyvalency, flexibility, and connectivity. We tested the model in Toronto, through weighted overlay analysis using ArcGIS and an online survey of 120 Toronto-based flooding experts, to identify how social vulnerabilities, flood exposures, and adaptation interventions are distributed within Toronto's urban form. This information enables us to identify which neighborhoods are experiencing the highest risks of floods.

The results reveal the uneven spatial distribution of flood risks, hence, identify four neighborhoods that should be prioritized for adaptation interventions: Thorncliffe Park, Flemingdon Park, North St. James Town, and Black Creek. Indeed, these are inner-city, high-density tower communities with old infrastructure and low-income, racialized, and migrant populations – typical of the 20th century modern tower block communities dotted across North America, Europe, and Asia. This study was part of a bigger project. Building on the experts' surveys, the following steps include working with the vulnerable communities through participatory and interactive processes to develop small-scale adaptive GBI solutions grounded on place-based experiences, representing the neighborhood residents' everyday lived experiences. Surely, as more empirical studies investigate the root causes of climate related risks in tower communities beyond Toronto and Canada, we will learn more about why certain communities will need to be prioritized in adaptation interventions and how we can work with them to advance just climate solutions that are grounded in the communities' context-specific needs.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of Waterloo Research Ethics Board (ORE #42887). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

NM: research design, investigation, conceptualization, methodology, data curation, formal analysis, literature review, and writing—review and editing. LK: research design, conceptualization, writing—review and editing, supervision, funding acquisition, and project administration. Both authors contributed to the article and approved the submitted version.

FUNDING

The funding for this research project was provided by the Social Sciences and Humanities Research Council of Canada (SSHRC) under file number 435-2016-0243. Dr. Amrita Daniere funded the open access publication expenses of our paper. The funders had no role in our research, including manuscript preparation, data collection, and analysis.

ACKNOWLEDGMENTS

We are sincerely grateful to the experts who shared their valuable insights through surveys. We would express our deep gratitude to Dr. Alireza Najma for his assistance with analyzing the survey results. Last but not least, we would like to express our special thanks to Dr. Amrita Daniere, who kindly funded the open access publication expenses of our paper.

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 11 August 2022
DOI 10.3389/frsc.2022.936809

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 05 May 2022
ACCEPTED 21 July 2022
PUBLISHED 11 August 2022

CITATION
Shtob DA (2022) Readiness at what cost? Trauma, displacement and opportunism in the Florida Keys. *Front. Sustain. Cities* 4:936809. doi: 10.3389/frsc.2022.936809

Readiness at what cost? Trauma, displacement and opportunism in the Florida Keys

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As more jurisdictions adopt climate and disaster readiness plans in response to disaster risk, the merits of climate resiliency, adaptation, and recovery processes and initiatives should be assessed based upon their outcomes as opposed to their stated or implied intentions. This should involve assessment of the experiences of early adopters, to assist localities with plans currently under development. The key question explored is what factors combine to exacerbate displacement risk in the long tail of a disaster aftermath, especially at the understudied intersection of political economy and disaster trauma? To address this question, I use in-depth interviews with residents of the lower Florida Keys in the aftermath of 2017's devastating Hurricane Irma, identifying a complex of drivers through which risk of unequal residential displacement took shape. Specifically, post-Irma bureaucratic delays contributed to trauma promoted displacement in local working communities; in some cases, these processes resulted from preparedness initiatives themselves. In addition to the well-known displacement that occurs immediately after a storm, this suggests that displacement risk may develop over long timeframes as residents are emotionally and materially worn down by repeated frustrations. Identifying how disaster readiness initiatives contribute to these processes emphasizes the need for enhanced attention to the places and populations that they are intended to protect, as well as the generative power of their interactions with everyday bureaucracy and government function. Furthermore, this community's experiences invite future research to better understand how resilience, adaptation, and public safety initiatives interact with political economic context in ways that can result in sociospatial inequality, providing caution and suggesting avenues for reform.

KEYWORDS

disaster, resilience, environmental justice, housing, qualitative, hurricane

Introduction

Shortly after Hurricane Irma decimated many areas of the lower Florida Keys in September 2017, Bloomberg News characterized the area's post-disaster experience as the bellwether of "America's Great Climate Exodus" (Gopal, 2019). With climate change predicted to increase the severity of hurricane impacts (IPCC, 2014; Angus, 2016), social scientists have explored how political economic contexts influence planning, response,

and recovery (Tierney, 2007, 2015; Gotham and Greenberg, 2014; Dawson, 2017). The concept of community displacement has also gained center stage, with enhanced focus on why people remain or stay after a disaster. Important as these studies are, however, they tend to focus on disaster impacts in a few large cities, such as New York City's experience with Hurricane Sandy and that of New Orleans with Hurricane Katrina (e.g., Freudenburg et al., 2009; Adams, 2012; Gotham and Greenberg, 2014; Tierney, 2015).

They also tend to focus on the aftermath of disaster and to see pre-existing political economic context as the primary driver of vulnerability, occluding the ways that expectations of future environmental change may themselves change political economic context and disaster experiences (Pais and Elliott, 2008; Anguelovski et al., 2016). In this exploratory paper, I begin to address the need to better understand how the interrelationships among political economic, bureaucratic, and emotional stressors contribute to displacement, including stressors that result from disaster preparedness initiatives themselves. I do so through a case study of the lower Florida Keys' experience with Hurricane Irma, emphasizing the generative power of pre-disaster resilience planning in a relatively ideal test site: a small community with high disaster risk, an involved planning history, and elements of sociospatial inequality formation reminiscent of resilience gentrification (Gould and Lewis, 2018a; Shtob, 2022).

To analyze how sociospatial inequality develops, I synthesize the "production of disaster space" (Shtob, 2022) with literatures on natural hazards, displacement, trauma, and environmental justice. Building upon these literatures, I ask: how political economic and bureaucratic pressures, particularly those surrounding housing, real estate, and recovery itself, interacted with emotional trauma in the process of post-disaster recovery; how these combinations of political economic and emotional factors impeded attempts to recover and rebuild following Irma; and how together they may have promoted displacement of individuals and communities? The goal is to advance a synthetic approach to recovery analysis that admits a multitude of stressors and emphasizes their cumulative nature, rather than viewing each separately.

Results suggest that pre-existing bureaucratic practices made worse by the disaster, delays and frustrations with aid, insurance, and other elements of the recovery process, and disaster-related regulation combine to create pressing, long-term, post-disaster trauma that often exceeds the trauma of the initial event. In turn, this cumulation of stressors and trauma wears down residents in the months and years after a hurricane—well after most relief efforts have ended—creating susceptibility to displacement, often through speculative real estate pressure. In turn, this suggests that some common and intuitively reasonable bureaucratic and disaster planning practices may contribute to housing and community precarity, suggesting avenues for further study and eventual reform.

Literature review

Displacement, political economy, and emotional content of the disaster cycle

Population displacement is central to social science disaster analysis. While displacement and migration are sometimes thought to consist of unidirectional depopulation (Goodhue, 2018), organized managed retreat (Koslov, 2016), or officially-sanctioned abandonment (O'Neill et al., 2016; Flavelle and Mazzei, 2019), other studies hint that climate-related migration instead involves multi-directional churn: internal relocation, displacement, and external replacement (Fussell and Elliott, 2009; Curtis et al., 2015; Gould and Lewis, 2017, 2018a). Moreover, displacement due to economic circumstances and environmental risk is rarely fully compelled or fully voluntary. Instead, it involves a complex array of considerations that include affordability and distance from social support structures (Fussell and Elliott, 2009; Curtis et al., 2015).

For those in the "middle of the volitional continuum" between forced and voluntary migration, disasters can promote migration and displacement through complex combinations of structural and individual circumstance (Fussell and Elliott, 2009, p. 382). Building upon a decades-old social science interest in housing and displacement following disaster (Quarantelli, 1995) recent research has begun to explore these varied drivers and motivations. For example, an early piece (Levine et al., 2007) observed that we often focus on short-term relief to the exclusion of impediments to medium- and long-term housing recovery like fragmented or uncoordinated official response and the operation of legal and other structures that regulate recovery. More recently, McAdam (2020) emphasized the distinction between evacuation around the moment of disaster and the more arbitrary displacement that comes later while Essig and Moretti (2020) demanded greater anticipatory attention to causes of displacement risk. Rhodes and Besbris (2021) focus on a different element of pre-disaster planning, finding that among middle-class flood survivors in Houston eventual displacement is partially a function of pre-existing desire to leave or remain in the area. Conversely, however, there is the question of what happens in contexts where the desire to stay proves unacceptably onerous over the long term: in other words, what factors render this desire to stay more or less durable?

While recent efforts have explored possible factors like the effects of federal aid schemes on maladaptive post-disaster outcomes (Howell and Elliott, 2018), the same cannot be said for the displacement effects of everyday bureaucracies or many resilience initiatives. This hinders our ability to understand how the combination of ordinary government functions, extraordinary initiatives attendant to disaster, and their emotional consequences affects the desire or ability to stay. For example, Hunter et al.'s (2015) comprehensive review of the

climate migration literature highlighted the need for enhanced attention to inequality and structural political economy but omitted the question of how these interact with efforts to ensure more resilient futures. Moreover, its calls to highlight perception research and to examine long-duration community strain rather than exclusively focus on short-term relief stands in stark relief against the apparent absence in the then-existing literature of exploration of the full range of interactions among emotional, housing, and economic elements of displacement (Hunter et al., 2015).

Similarly, a recent review of the sociology of disaster literature called for additional studies of movement and displacement, as well as greater integration of disparate but related topics like mental health, housing, long-term approaches that include pre-disaster periods, the role of government beyond post-disaster aid regimes, and how decision-making strategies result in feedback loops that increase inequality and land development. Yet there is a notable absence of studies intended to disentangle these feedback loops by integrating pre-disaster adaptive strategies, emotional health, and the role of mundane government function like local housing bureaucracy and building codes (Arcaya et al., 2020).

This presents an opportunity to explore the emergent question of how the material and emotional content of post-disaster life may, in tandem, result in opportunism, the exploitation of disaster, or inequality formation. Disaster related displacement may operate similarly to green gentrification, as environmental amenities in the form of preparedness or resilience initiatives may be initiated due to the efforts of growth machine coalitions focused on real estate development that influence government decisions (Logan and Molotch, 1987; Gould and Lewis, 2017). Moreover, a green veneer may obscure the risk of inequality, displacement, and intensifying growth (Foster et al., 2011; Gould and Lewis, 2018a). Pais and Elliott (2008, p. 1419) consequently argued that disaster growth machine theory should explore how "struggles [over local development] change after a major disaster hits, as competing interests respond to opportunities created by the damage, displacement and rebuilding." Similarly, Gould and Lewis (2018b) demonstrated that on the Caribbean island of Barbuda post-disaster development decisions that carried displacement risk were recharacterized as more palatable relief or humanitarian efforts.

A complicating factor is that environmental justice analyses sometimes assume that disasters "land" on pre-determined sets of infrastructural conditions and social relations rather than contributing to their development. Studies that operate under this assumption run the risk of omitting the effects of disaster planning and response initiatives themselves (Klein, 2007, 2018; Tierney, 2007, 2015; Anguelovski et al., 2016; Dawson, 2017; Gould and Lewis, 2018a). In a time of rapid environmental change, viewing disaster planning not merely as derivative of pre-existing conditions but as formative—and formative in distinctive ways—may provide insight into the unintended, unspoken, or truly unforeseen consequences of disaster planning (Shtob, 2022).

Emotional and material links in the production of disaster space

The production of disaster space (Lefebvre, 1991; Shtob, 2022)—how our built and social environments are produced throughout cycles of disaster planning and response—provides a foundation for a synthetic approach analyzing how different political, economic, practical, and emotional factors might shape these consequences. According to Lefebvre (1991, 2003) space is produced at "the intersection of knowledge and power…[in ways] pertinent to those who wish to control social organization, such as political rulers, economic interests, and planners" and in turn reproduces the structures that create it (Gottdeiner, 1993, p. 131). Because space and place are valued not only for their cash price but for their meaningful aspects like relationships among people, society, and landscapes (Greider and Garkovich, 1994; Gieryn, 2000), these are likewise relevant to spatial control through planning. While disaster zones are subject to the same political economic forces as any other, they are distinctive because of the risk of periodic destruction. Therefore, the planning elements of spatial production and resulting sociospatial control in disaster zones may also involve protective efforts, recovery, repair, and replacement. Additionally, disasters themselves can clear pre-existing structures without an assignment of blame to any human, obscuring political economic imperatives (Lefebvre, 1991).

The production of disaster space is similar to approaches focusing on the cumulative effects of concatenated crises (Gotham and Greenberg, 2014) but with a more explicit focus on disaster expectation and planning in addition to disaster response. With the number of resilience and preparedness programs rapidly expanding due to climate change and recognition of its cost-effectiveness (Colker, 2020), pre-event initiatives are of the moment and should be folded into our understanding of the political economy of disaster. One of the myths surrounding disaster (Tierney et al., 2006) may be the assumed win-win nature of these measures. Using the production of disaster space as a lever to question this myth provides an opportunity: because any municipal resilience efforts are in their early stages and there are emergent fiscal incentives for municipalities to get on board (Moody's, 2017, 2019; Omstedt, 2020), the question how the political economy of housing and displacement operates in often emotionally charged and traumatic disaster contexts deserves additional attention.

Disaster, collective and cultural trauma, and environmental justice

One way to introduce the emotional content of disaster into housing is through cultural and collective trauma. While individual trauma involves a "blow to the psyche" (Erickson, 1991, p. 459–460) collective or cultural trauma typically develops from the loss of a sense of community or official support. Critically, it may impact those who did not experience the disaster firsthand but experienced its aftermath (Erickson, 1991, 1994; Alexander and Breese, 2011; Eyerman, 2015). Because space and social relations influence each other (Lefebvre, 1991), housing loss and trauma derived from failures in institutional response (Eyerman, 2015) are at the core of disaster experiences. Therefore, it is reasonable to expect that trauma may result from, and contribute to, the production of disaster space through housing and a sense of inequality formation after a disaster (including a sense of basic, disadvantageous unfairness in policies and procedures).

Accelerated environmental risk and injustice like accelerated landscape development, unequal accumulation of wealth, and increased residential instability all are associated with disasters, sometimes through planning and recovery schemes overlaid on pre-existing structural inequality (Elliott, 2015; Elliott and Clement, 2017; Elliott and Howell, 2017; Howell and Elliott, 2019). Yet questions remain about *how* many disaster preparedness and relief efforts fuel inequality formation (Howell and Elliott, 2018; Klein, 2018) through legislative, bureaucratic, and landscape development practice (Pellow, 2000). Critical environmental justice studies—a more recent evolution—advances these questions by asking whether the state is necessarily an ally in environmental justice efforts and by reminding us that all people are "indispensable to our collective futures" *in place* (Pellow, 2018, p. 26).

Displacement, even that which occurs in the middle of the volitional continuum (Fussell and Elliott, 2009), is implicated by each approach. First, disaster-based displacement threatens indispensability because it involves relocation that is often not fully voluntary. Second, it involves analysis of past, present or future government action, including seemingly neutral or prosocial activities that produce space in unequal or unjust ways. The idea that disaster trauma may result from disappointed expectations about recovery rather than from the storm experience itself (Eyerman, 2015) emphasizes the need to reconsider a variety of government and private aid and resilience programs, how they may create or support individual or community trauma, and how in combination these may result in displacement and associated environmental injustice. Drawing together the emotional content of disaster aftermaths with practical considerations involving insurance, aid, rebuilding bureaucracy, and preparedness regimes, I introduce a new exploratory synthesis of how these potentially mutually influencing drivers of displacement and environmental injustice that unfold in long-term post-disaster recovery. Put simply, the goal is to use the production of disaster space—the ways that we build around disasters in line with human priorities—to more broadly integrate potential drivers of displacement that rarely have been addressed in concert.

Methods

In order to understand the intersection between the production of disaster space, political economy, disaster trauma, housing displacement, and environmental injustice, I used the lower Florida Keys as a case study (Yin, 1994, 2003). My data collection strategy was inspired by contemporary grounded theory (Charmaz, 2006) as well as the theoretical reevaluation and reconstruction suggested by Burawoy's (1998) extended case study method. The central element of this data stream was twenty-two in-depth interviews conducted in person and less often by telephone between 2018 and 2019 with residents of six separate islands in the lower Florida Keys ranging from Key West to the southwest to Big Pine Key to the northeast. Every participant lived in the area prior to Hurricane Irma, had personal experience with the storm aftermath, and at the time of their interview had been resident between 5 and 48 years. The participant pool featured members who were retired, actively working, year-round residents, seasonal residents (or "snowbirds"), at least seven who were dispossessed from their house for more than a year and a half, three who no longer lived in the Keys because of Irma, and a few others who at the time of our conversation were considering leaving due to Irma's aftermath. It was evenly split between men and women, with ages ranging from 31 to 87 and a median of 54.5. Housing experiences in this group varied significantly; while everyone reported being affected by Irma, some only suffered superficial damage while others returned to complete destruction.

In order to identify people with both strong local ties and personal experience contending with Irma, participants were initially recruited through community service organizations and related key informants. Thereafter, recruitment continued *via* snowball sampling, including strategic oversampling of those especially active in the community or with a breadth of community connections. With one exception all interviews were all an hour or more, with some exceeding 2 h. Initial questions asked about personal beliefs and demographics, as well as how participant ended up in the area. From the outset, relationships between housing and population displacement appeared to be important so a second set of questions focused on past, present, and future housing circumstances as well as observations about neighborhood shifts after Irma. Being conscious of the somewhat unique relationships that Keys residents have with place, a variety of questions focused on place relationships and how these interacted with the long-term disaster experience. Finally, a variety of questions focused on the

Irma and its aftermath, inviting free responses about factors that helped or hindered recovery.

Many questions were open-ended and intentionally vague, which allowed participants to answer them as specifically as desired. This prompted them to provide their own definitions for concepts as diverse as their community or communities, environmental change, recovery, and expectations for the future. In this way it tested salience of ideas and concepts and promoted ideational and thematic development, allowing participants to highlight issues and stories that they felt were most relevant, rather than limiting its scope to a predefined list of research topics. One result of this is that many participants framed their responses as pre-Irma and post-Irma observations, experiences, and opinions: Irma served as a catalytic socioenvironmental moment. Another was a pivot in topic from one focused primarily on the political economic roots of displacement to one that embraced the relationships among emotional trauma, things like housing and building codes, and bureaucracy.

During the coding process attention was paid to the development of novel categories, as well as general content of each category and stories that might represent potential outliers. While originally about 14 coding categories were contemplated, by the end of the coding and recoding process 20 often-overlapping categories were established. To be clear, these codes likely represent neither a full inventory of every factor that is play in this community nor every opinion held by residents. Moreover, an exploratory study focused on the relatively unique environment of the lower Florida Keys cannot inventory every concern held by the diverse array of communities preparing for disaster. As Burawoy (1998, p. 17) reminds us, "most communities are so riven by conflicts that it is impossible to navigate them to everyone's satisfaction no matter how careful the observer." However, by using the case study method and triangulating a variety of data sources, it is possible to capture a variety of thematic elements relevant to local recovery. Taken together, these themes were intended to provide guidance about ways to ameliorate maladaptive entanglements between housing, displacement, post-disaster trauma, and political economy.

Results and discussion

After a brief discussion of people and place in the lower Keys to introduce economic and housing pressures that existed before Irma, I outline some instances of Irma related trauma that originated not during the storm but through the management of its aftermath. The connectedness between trauma and housing allows us to connect the emotional content of disaster (Erickson, 1991, 1994; Eyerman, 2015) with political economy and environmental justice. I then argue that, in addition to the well-known displacement that occurs immediately before and after storms through evacuation and housing damage, there may be a brand of displacement that occurs over longer timeframes as residents are worn down by bureaucratic disappointment. This appears to be the cumulative product of regular bureaucratic ordeals transposed onto the difficulties of housing recovery after a disaster and exacerbated by housing policies focused on disaster preparedness in this highly vulnerable, early-adopting island chain.

To illustrate the potential, unexpected contributions of preparedness and public safety initiatives, I briefly outline two examples: the 50% Rule, part of a hurricane-resistant building and reconstruction code; and the Rate of Growth Ordinance (ROGO), a population growth limitation intended to ensure effective evacuation. In combination, the accounts to come suggest a new model in which less affluent community members experience the risk of displacement due to continuing and compounding frustrations with the process of recovery, while wealthier people are able to pay for convenience as they build back bigger. This combination of pressures wears down some dedicated community members, convincing them to leave well after the disaster event. For others, it creates significant questions about their willingness to suffer through another recovery, emphasizing the effects of concatenated disasters. Finally, I turn to a discussion of the real estate speculation that is common in the Keys and believed to have accelerated following Hurricane Irma, intensifying building development, diverting it toward tourism and temporary rentals, and possibly taking advantage of the bureaucratic grind experienced by residents. These observations suggest that long-term emotional trauma can serve real estate investment interests to the detriment of existing communities.

The lower Florida Keys: Place, political economy, and precarity

Starting off, it may be useful to frame participants' relationships to place and emergent threats to place that predated the storm but seem to have intensified afterwards. Participants nearly universally liked their birth or—much more often—adopted home in the lower Keys. Most participants reported that they had been attracted to this subtropical island chain uniquely connected by a single road to the U.S. mainland due to some combination of sunshine, water, and recreation. A common story was that participants came on vacation, fell in love with the area's environmental amenities, and decided to move in.

Participants cited the cost of living as a trade-off for living in the Keys. The area is expensive and recently, increasingly so. Second jobs and side hustles, particularly in tourism, seem to be the norm for younger working people and even some retirees reported working to make ends meet. Nevertheless, most participants reported strong satisfaction with their community.

It was nearly universally described as laid back and often as having a friendly, caring, and helpful small-town atmosphere. Yet this was countenanced by concerns about long-term real estate development trends, as well as conversion of previously affordable residential areas to expensive tourism and vacation rentals that detract from the sense of community while driving the area's economic engine.

In the words of a retired businessperson and snowbird who split her time between a home up north and one in the Keys:

> [The] most important things [in local history] are bad things.…They're mostly the tourist development. And it's just too fast and too much and too much money.…We once had a home [up north] and it's the same thing: the little cottages and the farms get bought up by people with more money than they knew what to do with and…because your taxes went up so high, you can't keep your farm and you sell out to somebody that builds a McMansion that they live in two weeks out of the year and…the whole character…changed.…..And of course after the hurricane that's worse [and it's] just overall overpopulated way too much, way too soon. And now with the destruction and the opportunities for more development I think it's going to get worse.

Part of her dismay was related to a strong sense of community: her house was completely destroyed by Irma and she appreciated the community she discovered thereafter, with neighbors pitching in as she rebuilt. Like others, she was concerned about how this economic squeeze would impact the local sense (or existence) of community. This includes a common thematic concern about whether the area's affordable housing stock is sufficient for local workforce needs. A minority of participants disagreed. They saw tourism development as the natural and beneficial outcome of the Keys' growth trajectory. A real estate professional active in local tourism promotion opined:

> Yes they were trying to do a lot, mainly tourism… to keep the Keys stable financially. Because it is truly the tourism [that] pretty much runs the economy there and without the tourists coming it's a domino effect.…If they don't have the tourists they don't have the people to run the restaurants and stores and shops and if we don't have that, then the people have to leave because they can't get good jobs.

That she lost her home to Irma and left the area due to difficulties with recovery underscores the complexity of participants' relationships with these issues. While most people expressed concerns about the accelerating rate and intensity of development, many either discovered the Keys as tourists or were wholly or partially dependent on tourism for their livelihoods. The conversation about loss of place and community was usually less about whether tourism should continue and more about how tourism affects housing and cost of living, as well as how symbolic battles about tourism reflect the greater question of "who are the Keys for?" This pre-existing sense of precarity was described by participants as intensifying due to Irma, as the process of place conversion accelerated.

Trauma machines: Storm aftermaths, housing, and rebuilding

All participants spoke about the trauma experienced during and after the storm, either personally or by reference to others. In nearly every case it was related to housing, bureaucracy, and the stress of rebuilding. Yet there was a qualitative difference between the short-term trauma of confronting the storm itself and the cumulative trauma arising while confronting the long grind of rebuilding and bureaucracy: acute yet short-lived trauma was experienced initially, yet a more onerous, chronic form of trauma appears to have developed thereafter. For this reason, I begin by outlining the phases of disaster trauma described by participants, as well as their sources.

Short term: Irma, evacuation, and early returns

The first moment of stress described by participants arose as Irma approached, businesses and workplaces shut down, and evacuation orders were issued. Many struggled to find a place to go, especially with much of Florida at risk. Despite these hardships these stories were generally jovial. Many participants felt that hurricanes were just part of local life and while evacuation was inconvenient and exhausting, it was not intensely traumatic. To the extent that accounts of this period involved stress it tended to arise from practical issues like the desire to not impose as a long-term houseguest or finding fuel on the road. Despite stress and difficult choices, these stories carried a significantly more positive attitude compared to those that came later. For long-term residents, part of this seems related to experiences with past hurricanes, which were milder than Irma. These cultivated a hopeful sense that Irma would be more inconvenient than tragic.

There was no lived precedent for the scale of destruction that participants encountered when they returned weeks after evacuation, and the tone of rebuilding stories turned quickly away from jovial. Accounts of the moment of return and absorbing the extent of the aftermath and recovery to come became especially ominous in connection with mental health. One participant who suffered minimal damage to his own residence but helped others' recovery expressed sadness seeing debris piled high on the roadsides: tangible reminders of destroyed housing scattered across the landscape.

> Before the hurricane, I was pretty much happy all the time. [The Keys were] uplifting and laid back and comfortable. I will tell you that since the hurricane it had a profound effect on my psyche. . . .I'm a member of Alcoholics Anonymous. I've been sober for [decades]. And right after the hurricane, I went to meetings twice a day for six weeks. Now, in normal time. . . I only go to AA meetings once or twice a week. But right after the hurricane, I needed structure. . . and I needed a place to go and be able to talk to people and commiserate and cry. Because it was utterly depressing.

Even those who were spared the worst of the storm reported an empathetic shock those first few months. Those who suffered significant housing damage, however, focused on the emotional consequences of the cleanup. One homeowner in his 60's who lived in a camper outside of his house while repairing and cleaning up described "Irma zombies" that resulted from the overwhelming scale of destruction and realization of the long-term nature of recovery:

> Just the work that we put in right after the hurricane. . . cleaning up. I mean, it was just. . . 12 hours a day and just working straight in the heat, and it was hot. You hear people call it. . . Irma zombies, you're an Irma zombie because [you]. . . just don't know what to do. I mean there was just so much stuff to do that we couldn't do it all.

Stories of immediate post-disaster sadness, while common, were typically mixed with praise for volunteer efforts and deep appreciation for the swift influx of charitable, individual, and community aid. Accounts of the period immediately after the storm, therefore, indicate a time that was bewildering and overwhelming, yet for many still served as a comparatively hopeful prelude to periods to come.

Medium term: The frustration of recovery and rebuilding sinks in

The next stage—grappling with an extended reality of disaster that persists long after many emergency responders and aid organizations have departed after the initial weeks and months—sees the intensification of viscerally traumatic reactions (Erickson, 1991; Eyerman, 2015). Critically, the centrality of housing in these accounts strengthens as time wears on. Participants commonly began to identify human culprits when discussing this stage (as opposed to the anthropomorphized Irma), including local government, banking and insurance entities, and various opportunists who they believe preyed on economic and emotional vulnerability. Yet when describing the immediate aftermath, first responders who had worked in difficult conditions were usually praised regardless of the effectiveness of their efforts. In short, it is important to read these accounts not as blanket condemnations of government, government workers, or government efforts, but rather pointed criticisms of specific institutional practices.

One central thematic element at the intersection of housing and intensifying trauma was disappointed long-term expectations of recovery: a mismatch between the expected recovery time and reality (Eyerman, 2015). After feeling a short-lived sense of relief when aerial photos of his neighborhood were finally released well after Irma, one participant recounted:

> I looked down and there was a roof [on my house] and I said, well, there's something to come back to, and we were pretty excited to say, take a pressure washer, we'll wash out the house, we'll chuck the sheet rock and get started. But then when we walk in the house and inside the house were things that were my neighbors', that's when I was like wow, this is too much. I thought we'd just clean it up in a week or two. And I was pretty positive. . . but when you work ten days and you're only six feet in the door. And it was hot. Brutal. . . .And you realized as you drove back and forth around town that everybody was all messed up in some way. It was pretty rough. It certainly, instantly went to depression after about four weeks, and then I think now looking back on it I think everybody. . . has PTSD. I know I do. . . .It's so frustrating that there's so many suicides happening, there's a lot.

Like the Irma zombies, this underscores how the initial hopefulness of recovery turned to bewildered resignation over time.

Many participants described a mismatch between actual recovery time and what is assumed by aid agencies. For example, while reflecting on the stress experienced by many who were returning to no place to live, no job, and possibly a fractured community, one participant commented:

> Well, they knew they were coming back to nothing, right? And. . . the worst part of it is for some reason, when you're in a disaster, their limit is three months, right? They give you three months of help, and then they think we're out of here. So everybody left, the churches left, the Salvation Army was out of here. They were here for the most intense part, which was just coming back in. But after three months. . . everybody left. The tents went down.

This feeling of abandonment were compounded by feelings of being ignored and preyed upon. Participants bristled at a perceived preference for Key West tourism over the needs of residential areas, including greater commitments of resources and much faster cleanup in tourist centers. Many resented how their damaged homes were treated as spectacles. One complained about scrappers rooting through his possessions, taking anything of value, and leaving a mess for residents to

clean or face fines. As the extent of the aftermath and recovery exceeded expectations, resentment about outside involvement began to grow. Cultural trauma was forming.

Long term: A traumatic slog through bureaucracy

Housing delays and building codes

Why did long-term trauma develop in this way among these participants? One reason is the exhausting reality of being displaced and unhoused or underhoused. Among the participants were many who used or borrowed campers for temporary shelter, stayed with friends or family for long periods, moved away, or who were still experiencing precarity or substandard housing a year or more after Irma. One participant could see through the front and back walls of his house: he called this his air conditioning. Another described his illegally parked trailer that lacked potable water or a working toilet as the one you get when FEMA rejects your request. He also feared the county would discover and evict him, forcing him from the area. Those who were displaced or living in a damaged structure commonly reported the traumatic effects of recovery delays. Many reasons were cited for these delays, each of which was sufficiently common among participants to suggest that a complex of interrelated and identifiable sources of frustration, disappointment, and fear arose after the storm.

The first and most common theme involved frustration with local government bureaucracy, specifically with building codes, inspections, permitting, and other requirements. Outside of disasters, it has been suggested that "building code violations are likely to burden and punish poor homeowners who cannot afford the required repairs and to hurt poor renters who cannot afford the higher rental prices charged by landlords who pass on the costs" (Bartram, 2019a, p. 942). The literature likewise suggests that the aggregate impact of building code enforcement tends to support the interests of speculative growth machines to the detriment of those less financially able to quickly remediate issues (Bartram, 2019a,b).

Building codes and disaster have co-evolved: "building codes, as a general rule, followed disastrous fires, becoming more refined with each one" (Davis and Ryan, 2020, p. 212). They therefore combine to produce space in anticipation of risk, creating impacts (intended and unintended) during recovery (Shtob, 2022). Coupled with pre-existing antipathy toward county building code enforcement due to perceived overreach, there was an overwhelming sense that post-Irma permitting and enforcement were central factors that exacerbated post-storm trauma. This risks realizing what Blomley (2020, p. 5) calls "precariousness in property law," meaning "the work that [real] property does in structuring asymmetric relations of vulnerability and privilege."

While strong dissatisfaction with local housing bureaucracy preceded Irma, participants reported that the new hurricane-resistant building code—as well as a disaster preparedness element colloquially called the 50% Rule—foreclosed the opportunity to rebuild for many. Under this rule, the owner of a destroyed modest or mobile home must rebuild to the new code, including potentially elevating the home on concrete stilts or a soil mound. While old buildings do not have to be renovated to the new code, this changes if they are substantially damaged (meaning, at risk of oversimplification, that repair costs exceed 50% of the structure's preexisting market value). Beyond topography and weather, one unique thing about the Keys is that a significant portion of the population is familiar with building code minutiae. Nearly everyone knows the 50% Rule. This illustrates how the combination of pre-existing institutional structures like bureaucracy may combine with disaster preparedness initiatives in ways that can exacerbate frustrations and trauma.

While the county independently adopted this rule, its published communications are careful to state that its purpose is to ensure future flood insurance in the area from the National Flood Insurance Program (NFIP) (Monroe County, n.d.-b). Although it is a positive sign that the county takes the NFIP flood requirement seriously, it is not without consequence. The 50% Rule can be especially destructive to those living in ground level homes, especially mobile homes. In many cases "mobile" is a misnomer because these homes deteriorate over time, may be impossible to move without breaking apart, or may require relocation by flatbed truck at unaffordable prices. In many cases, residents own the home itself but rent the pad on which it sits. When a mobile home park closes, residents may therefore lose their homes and their investment based on the park owner's decision (Sullivan, 2018).

Participants described a similar process for mobile or modest ground level homes that were damaged in Irma. Because of their limited value and the high cost of construction after the storm due to limited availability of contractors and high material costs, the cost of repair could easily exceed half these homes' value, triggering the 50% Rule. Yet building to the new code may be impossible for those without insurance or substantial savings. Even for those with insurance, proceeds may be insufficient to rebuild because insurance is keyed to the lower value of the preexisting damaged home.

According to participants, this process forced many working- or middle-class residents to sell their lots for whatever they could get. In turn, this primed the area for speculative purchases of many buildable lots for development into vacation, tourism, or seasonal rentals, intensifying land use and fomenting displacement. While the effects of the 50% Rule usually apply to more modest houses, this is not always the case. One participant—a successful entrepreneur and community booster who lived in an enviable home on the water—chose to leave the Keys after her house fell under the 50% Rule and her

insurance refused to pay the full rebuilding cost. Part of the issue, she explained, was the cumulative effects of struggling to hold on through disappointment after disappointment: when the insufficient insurance check arrived after over a year after Irma it was the final straw. She could have continued fighting but was too worn down.

Codes and permitting—which bestow the legal right to rebuild—gained special significance for participants due to the scope of destruction and entanglement with trauma. To illustrate the many stories that laid mental health issues at the feet of bureaucracy, one participant related his astonishment at a well-known story of a murder-suicide that occurred after the decedent couple went to a county meeting looking for help that was not forthcoming.

> What you found that's strange in the Keys was…in the Keys we're happy people, easy go lucky…and everyone takes everything in stride. People live down here without air conditioning and they're thrilled. They don't go 'woe is me.' They go 'look at me, I'm living the dream.' And for them to pull the trigger, is stunning. And the people who did it, you're like what the heck, they were doing good and on their way back to rebuilding and…just got a new job and he killed his wife and himself. Holy crap.

When asked what might have contributed, he outlined the tenor of local bureaucracy and its associated inconveniences.

> I have an answer, personally for me it was permitting, [the county]....Oh, absolutely. They have made it so difficult to rebuild, incredibly monumental incompetence in the…building department. Not by the inspectors, but the people who run the department are incredibly incompetent. And you…make seven trips up here, just to turn in an application, and each time you go you get told a totally different thing, that's a 45 minute drive, and some people have to work five days a week so they only get one shot….And then they get told if you didn't record this at the records office and we got to go to the records office and the records office says we don't need a copy of that, we need a copy of the other thing, and they send you back to them and they tell you sorry I meant to tell you this one, and then you gotta go back to the records office, back and forth….

Participant accounts like this were supported by media reports stating that the area's already high suicide rate doubled in early 2018 and that these mental health effects only emerged after a honeymoon period of community togetherness (Klinenger, 2018).

This participant, like others, is careful to not blame any individual, instead focusing on the systemic frustrations arising from the bureaucracy through which decisions were made. Indeed, there was little participant support for a *laissez faire* housing free for all, without things like building codes, enforcement, or hurricane preparation. Unsurprisingly, people who have experienced a hurricane the size of Irma tend to support involved preparedness initiatives. Participants were less enthusiastic, however, about other effects of institutional resilience bureaucracies on their communities: implementation of the rules was the issue, rather than their wisdom. This suggests that the production of disaster space engenders multiple competing commitments that must fretfully coexist under the logic of resilience and public safety.

Many shared a tacit understanding that their frustrations do not apply to those with the means to hire professionals to deal with the paperwork and administrative requirements, especially for second or vacation homes that they did not need to occupy while rebuilding. A number of participants shared the wisdom of hiring private insurance adjusters, building code compliance inspectors, or contractors who would deal with the bureaucracy for a premium. This is similar to Tierney's (2015) observation that Hurricane Katrina survivors were required to take an entrepreneurial approach to disaster relief, advocating for themselves in order to be considered "worthy" of relief and aid. While these examples of the neoliberal "privatization of recovery efforts" expose how disaster recovery systems can support inequality by directing aid toward the already wealthy or entrepreneurially sophisticated (Tierney, 2015, p. 1338), opinions in the lower Keys reveal another facet.

This implicit requirement directs that individuals either hire expensive professionals or operate as skilled and patient bureaucrats, deftly and repeatedly navigating time-consuming, complicated, and frustrating administrative requirements. Indeed, the participant who was most sanguine about recovery reported getting ahead of the bureaucratic morass as a likely reason. For many, the consequences for failure are homelessness or displacement from the area. Some participants alleged intentionality in how permitting and code enforcement took place after Irma. They argued that the slow pace was intended to let houses mold and rot so they would be easier to condemn, bulldoze, and replace. To them, officials were expressing a preference for more substantial, and expensive, structures.

While proving or disproving intentionality is likely impossible, the imposition of bureaucracy through local permitting was a central factor in the development of cultural trauma: a sense of the failure of government to uphold the covenant to protect the public (Eyerman, 2015). Many participants felt abandoned or that there were active efforts to get rid of them by making a bad situation unbearable: they felt dispensable (Pellow, 2018) and in part this was due to rules intended to protect against disaster. Moreover, while participants typically were pleased with private, charitable efforts to assist, the same cannot be said about their interactions with insurers, mortgage banks, and official or quasi-official organizations that were tasked with post-storm assistance. Intriguingly, participants almost universally expressed support

for building back stronger—often motivated by the scale of Irma's destruction and cleanup—even while they decried the uneven nature of building code impacts.

Other contributors to cumulative bureaucratic trauma: Aid, insurance, and banks

Other prevalent themes focused on different elements of bureaucratic frustration, emphasizing that it involves multiple sources that interact with, but are not necessarily dependent upon, hurricane preparedness initiatives. One was a complaint that FEMA and other official sources of aid offered, in the words of one participant, "a false sense of security, a false sense of hope." Many participants related stories of waiting in the heat outside FEMA tents to apply for aid and a litany of frustrations including: insufficiently trained aid workers; temporary housing being issued haphazardly or at great distance; protracted fights over denials; and eventual assistance falling far short of what was needed and promised. Some participants said that if they experienced another hurricane they would not bother applying.

Many participants cited lack of communication and cooperation from insurance and financial institutions as additional sources of delay and frustration that exacerbated housing worries. For many residents, repairs could not begin without insurance and mortgage bank approval, so drawn-out process of haggling and denial became symbols of traumatic inertia. These frustrations also include the inability to find licensed contractors once insurance money arrived. Delays in insurance adjustment and payment meant that those who could afford to self-finance repairs were first in line. Those who depended on insurance often waited months and, in some cases, more than a year to simply *find* a contractor, even after insurance issues had been resolved. Some participants reported undertaking repairs themselves—if they had relevant construction skills—or going to extraordinary lengths to obtain help. Another complicating factor for those with mortgages is that insurance proceeds were sometimes held by their financial institution until they demonstrated proof of repair (i.e., progress payments), adding additional time and headaches and again providing reasons for contractors to prioritize those paying cash.

Some who suffered minor damage reported little friction with their insurance company yet others avoided contact with insurers by not filing minor claims or hiring private adjusters. Others reminded me that it is nearly impossible to adequately insure a mobile home, compounding the special precarity of manufactured home residents. Legally, mobile homes are often treated as personal property like automobiles and consequently are subject to different financing and insurance regimes than real estate (Sullivan, 2018). Accordingly, insurance adequate to rebuild to code may be unavailable for much of the area's working-class population. Although opinions about the insurance and mortgage process did vary somewhat, an important theme is that the bureaucratic runaround combined with various legal regimes contributed to an uneven terrain of housing recovery differentiated by wealth.

In total, the process that ground down less affluent homeowners started with the need to rebuild to the new, hurricane-resistant code. For some, that was end of the road: they were simply unable to repair based on a lack of funds and insurance. For those who committed to rebuild, delays resulting from building code and reconstruction bureaucracy were exacerbated by the need to satisfy insurer or the mortgage bank requirements, and finding contractors who would work on credit with others offered cash in hand. This added additional steps, expense, and delay to the process of recovery; the absurdity of this process led to one participant opining that "all insurance is a scam."

These themes represent a variety of factors—bureaucratic delays impeding rebuilding, consequences of a building code preparedness initiative, insurance and banking delays, and aid that promised more than it delivered—that may promote displacement over the months and years following a storm by generating continuing trauma, and caused participants to question whether they would have it in them to stay through another hurricane and recovery. This cumulation of frustration is sometimes missed in event-focused disaster studies: one exhausting, disappointing, and unfulfilling recovery may fracture the desire to stay through another. This suggests that the study of disaster displacement may benefit from a long-term view that combines observations about the durability of a pre-existing desire to stay (Rhodes and Besbris, 2021) with trends across multiple events (Gotham and Greenberg, 2014).

"Geography and money": Mechanics of speculative investment and complex displacement

It is unsurprising that hurricanes can be traumatic. Among these participants, however, the cumulative complex of administrative and bureaucratic delays and frustrations seemed more traumatic than the storm experience itself. While they expressed some fears developed from the storm event—and everyone said that they would follow the next evacuation order—it was the grinding weeks, months, and in some cases years of cleanup, rebuilding, uncertainty, and precarity that suborned the greatest sense of trauma. Triangulating participant accounts with county explanatory documents, local newspapers, and conversations with local experts reveals another angle: longer-term housing trauma and traumatic displacement may be the result of, as well as promote, speculative investment that continues the cycle of disaster and displacement.

Rather than a linear "great migration" away from risk, displacement in the Keys is better understood as out-migration, in-migration, and a significant but underexplored process of migration within: local population churn that also carries risks of substandard housing or constructive homelessness (Fussell and Elliott, 2009; Curtis et al., 2015; Gould and Lewis, 2017, 2018a). Whatever its precise form, participants reported that the hurricane, displacement, and the official response reproduced and intensified an overall development trajectory toward wealth and tourism in the lower Keys.

In addition to the 50% Rule, another hurricane preparedness initiative that appears to have contributed to displacement and turnover in favor of tourism and speculation is the so-called Rate of Growth Ordinance (ROGO). It traces its lineage to a statute passed in 1972 to limit development in the Keys and informed the 1986 Monroe County Comprehensive Plan (Monroe County, n.d.-a). A limitation of building rights—ROGO rights are required to build new residential or tourist structures—its purpose is to restrict population growth to ensure timely hurricane evacuation on the single road to the mainland. Its allocation formula uses a complicated system of tiers with their own structure, as well as a scoring system that accounts for land dedicated to the county, aggregation of plots, and donation of funds to retire existing development rights (each of these is intended to reduce overall growth pressure). Approval for one of the limited allocations may take years and may prioritize those with the means to buy multiple plots for aggregation or dedication, or to donate cash (Monroe County, n.d.-a).

Like the 50% Rule, however, it may provide incentives for the conversion of affordable housing to expensive housing and resort development and this may be exacerbated by hurricanes. This is because the ROGO development rights attach to plots of land but are also tradable: a plot owner can sell them and they attach to the purchaser's plot. In practice, this means that rights previously attached to affordable housing may be sold to developers of larger projects. In the words of one resident:

> In the past there was housing, more housing available to the lower class. And that lower class [who work at the supermarket] and you know, places like that…that needed…low-income jobs and so they supplied those. Like the trailer park…on Big Pine Key, which…three years ago now…was destroyed…basically about 150 trailers [of] affordable housing that were destroyed….They came in…and bulldozed all the trailers down and people either got given a bus ticket to get out of the Keys [or] some of them were really relocated. And…these development rights went to a condo that they were building [near Key West]. So, you know, those type of things keep happening where…these low-income transient rentals' [ROGO rights] are being bought up and moved. And hence, housing…was lost for the lower class. And then Irma basically took it to another level because…a lot of these other trailers had enough damage that they could not be repaired and they would have to be replaced by a single family residence.… So that's…out of the price range for many of these people.

This suggests that the ROGO system and the 50% Rule contribute to a conversion of available working-class housing to more expensive forms, even though the ROGO statute does conceptually address affordable housing. This likewise represents the conversion of the post-disaster ability to remain in place into tradable real estate investment. While this process did not begin with Irma, it appears to have accelerated after. It also reflects concerns about the bureaucratic grind that residents had to endure. If unrepaired, a significantly damaged structure and its lot might be condemned, and condemnation threatens a loss of the property's ROGO rights.

The ROGO system represents another well-meaning regulation that was enacted for the purpose of hurricane safety. The popular and economic appeal of efforts like this is emphasized, if by nothing else, by the fact that the entire participant pool—even those most critical of the official response and most concerned with its embedded unfairness—supported official hurricane preparedness and safety interventions. Yet like building codes, the 50% Rule, and the related bureaucratic morass, the ROGO system also has the potential to impact affordable housing and, consequently, displacement and community disruption.

While a precise legal analysis of the 50% Rule and the ROGO is beyond the scope of this paper, some observations about their perceived effects illustrate how institutional bureaucracy may combine with resilience or adaptive initiatives to promote recovery trauma and consequent displacement. This type of exploratory analysis in an early-adopting community may be especially important as more communities follow their lead. Moreover, they have distinctive logics and independent public safety justifications that distinguish them from typical green gentrification (Gould and Lewis, 2018a): they similarly operate within local speculative investment trajectories but focus on protection from nature rather than protection of nature.

A substantial majority of participants expressed concerns about the intensification of development after Irma, the loss of affordable housing (in the local parlance "workforce housing"), and the way speculative investment drove each. There was broad general agreement that amplified housing pressure due to real estate speculation priced out the vulnerable and exacerbated the precarity and trauma of recovery.

> Now I think…I wish they had better control over the overdevelopment….I mean, growth is not a bad thing. You have to have growth, but a good pace would be better. I think that the hurricane itself…has opened the way for opportunists. There are a lot of people that are manipulating the system to work in their favor.

The battle over development also manifests in perceptions of official involvement that build off of bureaucratic and other delays that result in displacement. These accounts link generalized frustration with the county with a perceived preference for tourism development. In the words of one participant who suffered a complete loss of her home and business but was trying to rebuild nearly 2 years after Irma:

> Well, I've seen the continued proliferation of bad money winning out with development. You know, you can buy your way through things. I've seen it on my own street, and…it's very public, a lot of times….I have been at the mercy of the other end of it where…government goes for the low hanging fruit. Well, they got to do something and my…those people over there…they're easy pickings over there. Let's see what they got going on their property.

The outcome was that speculators were able to buy lots for inflated prices. Additionally, they may be able to overcome housing recovery issues less stressfully than the average resident who, through it all, needed a place to live and might depart simply to put a roof over their head if recovery was delayed beyond a breaking point. Another participant who lost her rental and had to live with friends for nearly a year after Irma said:

> Housing became ridiculous. People were ending leases just to take advantage of [that] …and they were doubling rent almost. So, it made it impossible to afford anything. I mean, for us to rent a house…the minimum was $3,000. More than one whole paycheck for me…but they did it to everybody. So…that was really frustrating. Or people were trying to sell homes…"as is," for $300,000 and half the house is missing. I mean, because there was nowhere to live…so just to see people trying to take advantage of that situation.

Importantly, "half the house is missing" implies damage so severe that in addition to the lot price rebuilding would likely require demolition and removal of the remaining portion, then construction of a wholly new code compliant structure. This expensive and time-consuming process is likely beyond the means of many working-class residents. Many participants connected this speculative conversion, long-term pressures on those who wanted to rebuild, and emotional trauma. One participant expressed concern with the long-term mental health effects of community disruption resulting from real estate market pressure and bureaucratic involvement.

> There was some help. But it was…a very fearful thing when you don't know if somebody is going to…take your property away from you. You know, we live very simply down here and most of the people were…retirement age. You just keep going…..It seems to me that there are a lot of situations [that] could have been reconstructed very easily without too much money and it seemed like…people [were] thinking that they were going to get some financial help from the different agencies, but instead they condemned things. Instead of saying, 'well, this is really not as bad…maybe we could give you a little money'….Instead of that it was 'off with their heads'…and that's when people started to get really mentally sick from it.

When asked about what led to differences in disaster experiences, one participant's summary was "geography and money." Housing pressures got so bad after Irma that a primary topic of conversation—perhaps *the* primary topic of conversation—involved the fear that there were not enough workers to provide public services and work in tourism because they could not afford to live locally.

These discussions included descriptions of the need to bus resort workers down from the mainland or simply do without. The overwhelming use of the term workforce housing in many participant interviews, as well as in the media and government communications, suggests a certain working class precarity: rather than being indispensable (Pellow, 2018) less affluent inhabitants of the Keys are expected to serve some broader economic purpose. Yet hurricane preparedness initiatives traditionally have not foregrounded things like maintaining adequate housing over the long term. In fact, in some cases they appear to promote the opposite as they incentivize land use intensification for temporary or seasonal use.

This is likely a contributing factor both to local displacement and to environmental degradation: the creation of a system that indirectly incentivizes the replacement of modest, affordable residential structures with more expensive vacation structures. It illustrates a mechanism by which the production of disaster space can promote inequality through disaster preparedness efforts. Moreover, because these local rules and practices are developed in part from processes and efforts generalizable elsewhere (including NFIP regulations and standards and increased recognition of climate and disaster risk that invites response across jurisdictions), it provides a caution for later adopting coastal communities in the United States, especially as disaster planning gains salience.

Conclusion

This exploratory paper presents a new way of examining relationships between disaster readiness and housing based on the experiences of an early adopting community. Although developed in a somewhat unique area that recently became one of the few to consider abandoning some areas to climate change (Flavelle and Mazzei, 2019), it suggests that after a disaster, cultural trauma develops over long timeframes from failures of bureaucracy, disaster planning regimes, aid systems, and insurance and financial institutions to serve community needs without needless frustration and delay. Over time, these failures

wear down elements of the population, rendering less affluent community members more likely to give up and leave and more susceptible to real estate opportunism. Yet we should not conclude that concerns about affordable housing are completely missing from the lower Keys, or that local government and public servants do not care. After Irma, initiatives to improve affordable housing to ensure a viable local workforce were implemented, although it is debatable whether they will be sufficient (Wadlow, 2018).

The production of disaster space factors heavily in both the need for workforce housing and the conversion from truly low-cost mobile homes to comparatively expensive "affordable" housing. Hurricane responsive building codes and standards such as the 50% Rule may risk removing low-income housing from the market, leading to speculation and consequent inequality. Likewise, the Rate of Growth Ordinance was passed in anticipation of a future hurricane, and similarly it provides incentives to remove truly affordable housing from the market. Taken together, these and other socio-legal structures like enforcement regimes contribute to an exclusive vision of the lower Keys, in which only those with sufficient wealth to withstand a hurricane will remain (along with those needed to provide services).

Each of these mechanisms also promotes the development of bigger, fancier, more expensive structures to serve as vacation or investment properties. Alone—and especially when combined with regularly onerous bureaucratic requirements—they contribute to the mental exhaustion and trauma cited by many participants that, in turn, may provide opportunities for predatory behavior, may wear down even those who are committed to remain and rebuild, and may discourage community members from deciding to endure another recovery. These may become worse when public risk governance regimes like building codes mix with private risk governance regimes like insurance and mortgage covenants. Poorly executed, these bureaucracies foment collective and cultural trauma (Erickson, 1991; Eyerman, 2015). By so doing, they appear to cyclically support displacement and the intensification of development in ways that might seem familiar to green gentrification scholars (Gould and Lewis, 2016, 2018a), yet with a focus on protective environmental amenities like resilience and adaptive systems.

Yet the literature also suggests avenues for reform. At least one modern infrastructural analysis of building codes and resilience emphasizes encourages the use of incentives rather than penalties (Davis and Ryan, 2020). Following this path may have promoted swifter, more productive interactions with code enforcement after Irma. This is especially important because of the risk of mold and continued deleterious effects of exposure to the elements if repairs are not prosecuted quickly. Moreover, it could be especially beneficial if it was coupled with a relaxed bureaucratic regime tailored to the post-disaster context through recognition that the primary short-term goal is to provide stable housing in place, as well as post-disaster case management system in which trained professionals help residents explore their options and navigate aid and bureaucratic regimes. It may also be worthwhile to extend the recognized public safety and aid window to many months or even years after disaster, reflecting common recovery times, as well as to pivot from an adversarial permitting relationship to one that specifically considers housing inequality formation (Pellow, 2000; Bartram, 2019a,b).

Although this study is exploratory and limited to a particular case and a particular context, it marries the material and the emotional, showing how they create mutually reinforcing cycles that catalyze disaster—or the anticipation of disaster through planning regimes—into consequences for housing and communities. At the very least, our efforts to ensure effective disaster recovery should recognize the connectedness of these factors across contexts. Because disaster preparedness and planning regimes are often developed with good intentions and may be amended with a stroke of the pen, reform developed from these suggestions is possible in the many places and jurisdictions—large and small—that live with the risk of disaster.

Data availability statement

Subject to human subjects research confidentiality and other requirements, the deidentified raw data supporting the conclusions of this article will be made available by the author, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Research Compliance Services, University of Oregon. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Funding

This research was generously supported by a University of Oregon Environmental Studies Program Interdisciplinary Seed Grant as well as the Arnold Soderwall Environmental Studies Endowment Fund.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 30 August 2022
DOI 10.3389/frsc.2022.932070

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 29 April 2022
ACCEPTED 05 August 2022
PUBLISHED 30 August 2022

CITATION
Yazar M, Haarstad H, Drengenes LL and York A (2022) Governance learning from collective actions for just climate adaptation in cities. *Front. Sustain. Cities* 4:932070. doi: 10.3389/frsc.2022.932070

Governance learning from collective actions for just climate adaptation in cities

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Environmental policy research fails to integrate procedural and recognitional justice perspectives and collective actions in governance learning for just climate adaptations. Drawing on the insights of two cities experiencing climate impacts differently, Bergen (Norway) and Istanbul (Turkey), this paper assesses how collective actions influence different levels of governments (local to national) to learn from these actions to implement just climate actions in their localities. Using environmental justice (specifically recognition and procedural) and policy learning literature, we contextualize a three-governance learning typology that emerges through collective actions that may trigger governance structures for policy integration: governance learning by resisting, co-opting, and expanding. We identify what kind of learning is introduced to the existing governance structures in Bergen and Istanbul, and how that learning shapes or is shaped by the governance structures, local government in Bergen and local to national governments in Istanbul, while developing climate adaptation policies and actions. Overall, this paper shows what types of knowledge and information are incorporated or ignored after collective actions and how power mediates interactions between actors across multiple urban settings for just climate adaptation.

KEYWORDS

governance learning, collective action, just climate adaptation, Bergen, Istanbul

Introduction

Halting the risks carried by the impact of climate change is especially urgent for vulnerable urban communities, households, and social groups that are socio-economically disadvantaged and disproportionately exposed to extreme summer heat or flash floods (Wilhelmi and Hayden, 2010; Wolf et al., 2010; Hsu et al., 2021; Eriksen, 2022). The effects of extreme weather events triggered by climate change, such as flash floods in Europe or extreme heat conditions in the Global South, illustrate how cities' infrastructures and administrative capacities (e.g., governance structures) and responses are not prepared to climate exposures and stresses (Kern and Alber, 2009; Yazar et al., 2021). Such downsides, in turn, increase equity and justice concerns amid extreme climates. Many institutions in multiple urban settings try to address complex

socio-ecological and technical systems (SETS) challenges exacerbated by climate change through their already existing administrative knowledge and traditional governance structures. On the other hand, studies show that the traditional governance structures are ineffective in addressing extreme climate conditions, and new ways of doing things and taking actions are needed (Pelling et al., 2015; O'Brien, 2016; Broto and Westman, 2017; Keith et al., 2021; Yazar and York, 2022). To be able to do that, formal governance structures need to be transformed through the co-production of knowledge *via* bottom-up learning beyond the formal organizational structures.

Governance learning is an emerging field in the policy literature (May, 1992; Toens and Landwehr, 2009; Dunlop and Radaelli, 2013; Howlett, 2014). Much of the current works focus on the modes of learning, including both endogenous and exogenous sources of learning within or outside of policy fields or jurisdictions that affect policy integration (Heikkila and Gerlak, 2013; Biesbroek, 2021; Pahl-Wostl and Patterson, 2021). Policy integration is "a continues process of adjustment through reflexivity and learning (Biesbroek, 2021, p. 75)." Studies show governance learning can be achieved through effective participatory design that includes formal governance actors (e.g., federal-state officials), researchers, and consultancy groups (Heikkila and Gerlak, 2013; Newig et al., 2016).

Although new empirical and theoretical insights are growing in governance learning, less focus is given to what extent these knowledges are informed by practice for climate adaptation (Rouillard et al., 2013; Fink, 2019; Gerlak et al., 2020). Some strong institutional settings have the authority to push forward top-down climate change integration through hard regulations (Schoenefeld and Jordan, 2020). For instance, nature-based solutions as a climate adaptation concept have developed alongside the research and innovation agenda within the European Commission and the European Environment Agency (European Commission., 2015). Instead, other institutions or governance settings may depend on soft governance capacities with limited substantive authority but high interests in integrating climate change concerns throughout other agencies or departments, resulting in ineffective policy accumulation (Yazar et al., 2020; Biesbroek, 2021; Knill et al., 2021). Yet, no attention has been given to how collective actions, or "practice from the bottom-up," inform governance structure to learn what kinds of effective policies and actions are needed to be implemented to address complex and place-dependent climate adaptations in urban settings. Thus, this paper suggests that collective actions through citizen and activist engagements are essential sources for formal governance structures to learn how to implement robust climate actions in urban contexts.

Learning is not static or linear but dynamic and consists of multiple dimensions; thus, governance learning processes that aim for policy integration or inform "practice" either lead to transformation in governance structures or exacerbate the existing power asymmetries (York and Yazar, 2022). Especially when it comes to decisions about policy integration for climate adaptation, in terms of who is included and excluded from the governance learning structures, what types of knowledge and information are incorporated or ignored, and how power mediates interactions between actors across multiple scales become essential. The role of power structures or how urban elites' economic interests shape urban climate actions and increase environmental injustices are recognized and studied broadly (Bulkeley and Newell, 2015; Westman et al., 2022; Yazar and York, 2022). But more research is needed to explain how collective actions through civic actions trigger governments to alter their existing governance structures through learning from these collective actions to address climate adaptation and injustices in cities, especially those that are under threats of extreme weather events.

Drawing on the insights of two cities experiencing climate impacts differently, Bergen (Norway) and Istanbul (Turkey), we will assess how collective actions influence local governments to learn from these actions to implement just climate actions in their localities. Two case studies in this paper illustrate that learning from collective actions takes different forms and directions by the formal governance structures. Using environmental justice (specifically recognition and procedural) and policy learning literature, we identify a three-part governance learning typology that emerged through collective actions that may trigger governance structures for policy integration or change: (1) *Learning by resisting*, (2) *Learning by co-opting*, and (3) *Learning by expanding*. Following a brief exploration of policy learning and environmental justice literature, we will introduce a three-governance learning typology (Section Theoretical context: governance learning, collective actions, and just adaptation). Then we describe our methodology and data and its application to the two selected cases (Section Case studies and methods) and then outline the results of each case (Section Results from the case studies). We discuss the implications of collective actions on governance learning and climate adaptation and make suggestions for further studies (Section Discussion) and then offer some concluding remarks (Section Conclusion).

Theoretical context: Governance learning, collective actions, and just adaptation

Cities are framed as the foci for change, especially in global action for global environmental change (Ostrom, 2010; Bulkeley and Castán Broto, 2013). Effective local climate adaptation requires robust governance learning. Learning is defined as "the reflexive updating of beliefs on the basis of evidence, experience, and new information (Newig et al., 2016, p. 354)." Research on learning has been used dominantly in policy and social learning contexts, seeking questions around the types of institutional

designs that foster or hinder learning processes, how or when learning leads to policy integration or change, and to what extent learning processes can be devised (Benson and Jordan, 2011; Van der Heijden, 2014; Newig et al., 2016). Learning also becomes an increasingly used concept in environmental and climate change research, especially learning through collaboration with multiple actors within and beyond formal governance structures for environmental and adaptive governance, disaster recovery, and urban climate practices (Emerson and Gerlak, 2014; Hartmann and Spit, 2016; Bellinson and Chu, 2019). Governance learning refers to "the social learning process leading to a different governance structure and practice (Wolfram et al., 2019), p. 32".

However, the existing literature only identifies and focuses on formal actors (e.g., policymakers, private businesses, civil society, and academia) that are engaged in learning processes through *face-to-face dialog that is open and ongoing, cross-scale linkages*, and *formalized venues, rules, and shared routines that foster intentional learning* (Gerlak et al., 2020). In addition, learning has been conceptualized with policy-relevant lessons that come from related policy fields and how cross-policy fields affect policy learning (Dunlop and Radaelli, 2013; Howlett, 2014). Considering the available insights from the literature, we argue that collective actions and their actors (e.g., community members, activists) are generally sidelined from governance learning processes, mainly because these groups lack representatives under formal organizations that hinder their recognition by the formal institutions. However, learning from collective actions (e.g., bottom-up movements using their social capitals) and adapting the knowledge generated from these actions into formal governance channels could shape governance learning for *in-situ* and just adaptation actions.

Collective action is when individuals come together for a common purpose and improve group outcomes (Van Laerhoven, 2010) at multiple levels of influence on climate adaptation decision-making (York et al., 2021). This study acknowledges collective action, similarly, focusing on efforts of individuals in collective action to act in an equitable manner to strengthen just urban climate adaptation through activism and social capital. The vast literature on collective action in the environmental governance domain has unpacked many variables, including how and why individuals cooperate and what variables affect collective actions, including social capital, group size, and market access (Meinzen-Dick and Knox, 1999; Sullivan and York, 2021). On the other hand, we argue that much has been uncovered about how collective actions in the context of climate justice lead to governance learning. Historically, injustices are exacerbated in governance structures. Considering the extreme weather events triggered by changing climate, linking climate injustices in the context of policy learning literature is critical to identify to what extent governance learning might hinder or foster climate injustices in the decision-making processes.

Climate justice draws on the concept of environmental justice with its three overlapping dimensions of justice; distributive, procedural, and recognition (Schlosberg, 2009). Against this backdrop, climate justice focuses on the unequal distribution of climate change-related threats and the uneven ability to respond and mitigate their impacts among various social groups (distributive justice); the extent to which multiple actors, individuals, and groups are involved in climate decision-making (procedural justice); and whose knowledge, values, identities, and interests are respected and taken into account (recognition justice) (Schlosberg and Collins, 2014; Massarella et al., 2020). Recognition justice is getting more attention in climate governance literature as it underlies whose visions, knowledge, and values matter, while procedural justice examines the extent to which vulnerable populations' push back against asymmetric power relations favoring powerful political elites and decision-makers (Schlosberg, 2012; Hardy et al., 2017; Chu and Michael, 2019; Malloy and Ashcraft, 2020).

Governance learning may increase procedural justice in terms of involving diverse stakeholders in a formal governance structure. Still, we must look beyond simple inclusion on coalitions or appointments to understand whose knowledge, information, and perspectives are welcomed and respected, known as recognitional justice (York and Yazar, 2022). Each decision-maker might be equally recognized in a decision-making process, while the capability of each actor to participate in a decision might be ignored. Thus, recognition and procedure are not only inherently bound up with one another in terms of power in the creation, makeup, and dynamics, but they also emerge within the collective actions. Without collective actions, many historically excluded groups may be unable to affect change from within through social learning processes that are the hallmark of collaborative governance networks.

Critically, procedural justice may not be enough; instead, it must be coupled with recognition and capacity. The dominant actors within formal governance structures do not necessarily facilitate learning. In fact, studies find that formal actors, including policy entrepreneurs, resist learning and create obstacles for policy integration, especially in environmental and climate domains (Khan, 2013; Arnold, 2021). Hence, collective actions could influence decision-makers in formal governance structures to realize the immediate need to address local climate challenges and emergencies, either in disasters or long-term urban design. Yet, we hypothesis that learning from collective actions takes different forms and directions by the formal governance structures. Responding to this lacuna in the literature identified above, we identify a three-governance learning typology that emerged through collective actions that may trigger governance structures to alter their structure or adopt new policies inspired by collective actions (see Figure 1 for illustrations of a three-part governance learning typology for just urban climate adaptation). The following subsection introduces three types of governance learning

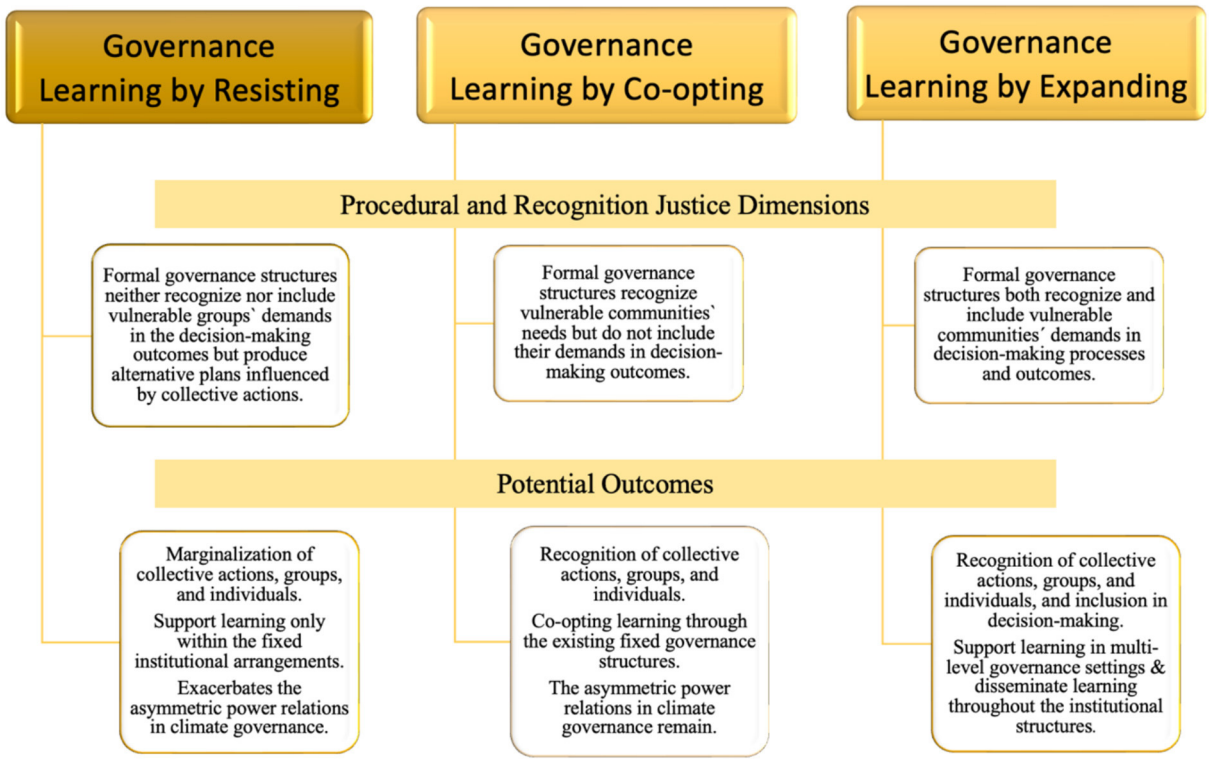

FIGURE 1
A three-part governance learning typology for just urban climate adaptation.

through collective actions: *learning by resisting*, *co-opting*, and *expanding*.

Governance learning by resisting

The critical argument we follow here is that there should be a meaningful linkage between collective actions and governance learning for which collective action creates a "leverage point for change" (Bryant and Thomson, 2021), either policy integration for adaptation or change in the formal governance learning mechanism. However, multiple factors can hinder governance learning for just adaptation in cities. One of the most pervasive obstacles to governance learning is the lack of open discussions and failure to include key stakeholders Mostert et al., 2007; Heikkila and Gerlak, 2019. Here, learning processes occur where formal governance actors adapt the knowledge generated through collective actions (e.g., collective actions through social capital or networks to demand change, for instance, better climate adaptation practices). Yet, the actors who generate knowledge through their collective actions are sidelined and, in some cases, marginalized due to the highly hierarchical socio-institutional dynamics (North, 1990) that hinder the learning process (Heikkila and Gerlak, 2019). In this case, governance learning happens while decision-makers utilize the generated knowledge but resist to include collective action actors into the decision-making processes (procedural justice). Consequently, the formal governance structure does not recognize the historically underrepresented groups (justice as recognition) and gloss over their demand but is influenced by their ideas to develop alternative policies.

Governance learning by co-opting

A growing literature in environmental governance explores the transformational potential of governance with collective decision mechanisms (Bowen et al., 2017; De Voogt and Patterson, 2019; Pahl-Wostl and Patterson, 2021; York et al., 2021). Here, learning by co-opting is understood that formal governance structures are enticing or forcing less powerful actors to their bidding. For instance, decision-makers might recognize and incorporate with collective action actors, but the outcomes of decision-making generally exclude the demands of the community members. In turn, lack of inclusion in procedures reproduces power imbalances in rigid climate

governance structures and co-opts seemingly governance learning mechanisms. For instance, extreme weather events triggered by climate change represent a social dilemma in which individuals have little incentive to act in society as a whole. Yet, it is rational for individuals to act within social groups (e.g., using their social capital) on their collective interest (Olson, 2009; Ostrom, 2010). With the increasing intensity of climate change-related events (e.g., flash floods, extreme heat), political elites and decision-makers rely less on resisting to adjust a new climate governance approach with collective decision mechanisms, especially in climate disaster and emergency planning and actions (Delilah Roque et al., 2020). In the times of climate emergency and disaster planning, collective actions might emerge across communities to address climate adaptation issues and lead to governance learning with the inclusion of more diverse voices (procedural justice). However, certain social groups have historically been marginalized and excluded from the formal governance learning processes. Lack of political and social capital and access means that marginalized groups will inevitably seek channels to be recognized and supported by the public and gain attention (recognition justice) from the formal authorities, resulting in co-option or elite capture amongst more vulnerable communities.

Governance learning by expanding

Expansive learning theory is a process of learning; namely, "it proposes an ideal-typical sequence of learning actions that together make an expansive learning cycle (Engestrom, 2014), p. 12." In the context of this study, we conceptualize learning by expanding in governance learning for just adaptation in cities as to what extent learning through collective actions is institutionalized in governance and decision-making processes. Governance learning by resisting and co-opting suggest that learning processes can side-line and even manipulate actors within collective actions and exacerbate power asymmetries in governance structures. Yet, governance learning by expanding reveal that learning by resisting and co-opting are insufficient to transform formal governance structures. Ultimately, we argue that the diversity of knowledge through recognizing and including vulnerable communities' demands in decision-making processes and outcomes are essential components of learning by expanding. Hence, in the context of governance learning by expanding, collective actions serve as both the enablers of learning processes and, ultimately, learning outcomes. Governance learning by expanding also improves the credibility, legitimacy, and acceptance of diverse knowledge produced through collaborative processes. It also enables formal governance actors to assess their assumptions and biases and learn together with actors (Armitage et al., 2008; Susskind, 2013).

Case studies and methods

The analysis focuses on two cities, namely Bergen (Norway) and Istanbul (Turkey). This study's empirical data is gathered through interviews conducted in Bergen (2020–21) and Istanbul (2019). This study's approach, including the reasoning for the two-case study selection and data collection process, is presented in the sections below.

Bergen (Norway)

In Bergen, Norway, there has been a growing focus from governance actors on sustainable urban development, climate mitigation, and to some extent, adaptation to ongoing climate changes. The city is exposed to extreme weather, causing landslides and urban flooding. Stormwater management is a major policy issue for the municipality, and the municipality recognizes that the problem will increase as the urban area is built up and developed as the urban population grows. Changed land use in urban areas as a result of compact city policies can have substantial effect on water run-off and cause significant adaptation problems with a changing climate (Bergen, 2019). As a result, the municipality has developed a strategy and multiple pilot projects with blue-green infrastructure and other nature-based solutions.

The recognition of the need to adapt to climate change, and the shift from traditional stormwater management to nature-based solutions, has led the to a shift in governance practice Kvamsås (2021). In the fall of 2005, there were two landslide episodes in the city, which causes in total four lives. These were primarily attributed to climate change and significantly raised awareness in the municipality of the need to account for future climate risk in policymaking. The episodes have been interpreted as the trigger event for a greater emphasis on climate adaptation in the municipality. Following the events, the municipality implemented new guidelines for stormwater management, ushering in a new paradigm in line with ideas of blue-green structures and nature-based solutions (Groven, 2013). As Kvamsås (2021) shows, the shift to nature-based solutions has promoted cross-sectoral collaborative approaches in governance that created space for professional negotiation and mediation between professions, city departments and sectors.

Bergen has since the 2005 events been considered a frontrunner in climate adaptation policy and has adopted ambitious climate goals both for mitigation and adaptation. On the mitigation side, the city has significantly constrained sprawl in its new master plans, it is expanding new Light Rail lines, and it is incentivizing electrification of vehicles. Still, the climate-related policy has been controversial in much of the population. There has been long-running political tension around the Light Rail project and the road tolls aimed to finance public transportation and limit traffic. The public mobilization

against the road tolls had a significant effect on the local elections in 2019, when the single-issue party People's Action No To More Toll Roads because the third largest party despite having been formed just months prior. In this and other issues, there are significant social divisions around green, climate-friendly policies in the city, concerning their merit, who benefits, and questions of financing (Wågsæther et al., 2022).

The analysis for the current case study is based on the process of building a public park in the city center, as part of the city's efforts toward climate resilient urban development. The park is integrated with a major public transport infrastructure investment—the Light Rail. This development has been broadly supported by the public, but also controversial among some groups. We will here refer to it as the City Beach project, the label used by local authorities. The park is conceived as a climate resilient ecopark concept focused on enhanced biodiversity, including potential effects of light pollution on biodiversity and consequently, adapted lighting solutions. It is planned to involve concepts for and prototyping of energy-neutral park design and technological solutions to improve local carbon footprint. Since 2018, there have been several processes of public participation and public hearings, which have shaped and continue to shape the park's design. The public participation has created tensions, as it has been unclear what the scope of participation is, how to fit public input into the bureaucratic process and how to reconcile public participation input with expert knowledge. Nevertheless, public input into the governance process has primarily been through the official institutional channels created by the municipality, unlike the Gezi protests considered in the Istanbul case.

Istanbul (Turkey)

Istanbul is the megacity of Turkey and is highly vulnerable to heatwaves and urban heat islands due to dense urban planning, high-rise buildings spurred by the construction-based economy, and decreasing green spaces due to dense urban planning. Such climate-driven risks coupled with the existing infrastructure intensify exposures. The city already experienced heatwave episodes totaling 14 days between 2015 and 2017, which caused 419 deaths (Can et al., 2019). Future climate scenarios also project that flash flood will increase in Istanbul due to deforestation and the lack of green infrastructures (Cetonkaya et al., 2022). Although the 2011 National Climate Change Strategy and following national action plans and programs (e.g., the 2020 National Smart Cities Action Plan) recognize climate change-related challenges in cities, these plans remain insufficient to provide climate adaptation targets for cities in Turkey. Local governments have some individual authority which is best seen in developing their climate action plans (Kuokkanen and Yazar, 2018; Thornton et al., 2020). On the other hand, researchers find that when it comes to climate change, local governments in Istanbul do not use their ability to allocate budget generated through their own-source revenue granted by the Municipal Law (Yazar and York, 2021). Instead, the local governments prioritize profitable urban development plans over *in-situ* climate solutions to mitigate the impacts of extreme weather events in the city.

The 2013 Gezi Park protests were a significant milestone in Turkish environmental activism, particularly affecting national and local governments' environmental agendas. Gezi Park, located in Taksim Square, is one of the few remained green areas in the urban core. The 2013 protests started to oppose the national government's urban development plans to transform the Park into a large strip mall. The protests evolved something more extensive than the Park itself and aimed to conserve urban green in cities, predominantly in Istanbul. The protests have reached an age where numbers of neighborhood associations and groups are emerged with urban green agendas, in turn contributing to urban climate adaptation. Unlike in the Bergen case, the Gezi Park movements triggered the national and local governments in Turkey to reassess their urban green agendas. Therefore, for the Istanbul case, we will focus on (1) how the collective actions in the Gezi Park triggered the national government to realize urban green agenda for the country (national-scale), and (2) how the protests affected a local government (Uskudar district municipality) in Istanbul to reassess its urban green plans in the Kuzguncuk neighborhood (local-scale). The Kuzguncuk allotment garden is selected for its long history of community-based allotment gardens and one of the most significant green infrastructures (e.g., tree canopy) that could host large communities in the district. The local municipality and the developers tried to develop many projects (e.g., building a new hospital, school, parking lots) on the land, as the garden has been in deadlock for some years due to complex ownership structures. The 2013 Gezi Park protests, however, were one of the turning points in which the local conservation groups won the hearts of the locals using various means (e.g., organizing community forums, festivals, and gatherings) and pushed the local government to conserve the allotment garden for multiple nature-based related activities. The local government realized the bottom-up demand and urged to address the local needs considering the political environment was rising in the city. Confronted with these masses, the local government decided to freeze the development projects planned for the allotment garden in 2014.

Methods and data collection in the case studies

The article authors draw on long-term engagement with the cases at hand, and experiences from multiple research projects on the broader theme of sustainability and governance.

In the specific cases discussed directly in the article, we here use original data. Both case studies rely in semi-structured, one-on-one interviews conducted, as well as a range of document material. The interviews in Istanbul ($n = 14$) were conducted in 2019, and the interviews in Bergen ($n = 16$) were conducted in 2020–21, all by members of the author team. Interviews in both locations were conducted with governance actors, civil society activists, representatives of civil society organizations, local outreach coordinators, and other stakeholders, including volunteers, as well as officers from the national government and the selected municipality (see Supplementary material). The participants were selected through snowball sampling, and interviews generally took 30–45 min, with some communications through email and phone calls.

The interviews were conducted to capture similarities and differences of a wide range of perspectives on a three-governance learning typology introduced in this study. The interviewees were asked questions related to the collective actions raised in the City Beach Project (Bergen) and the Kuzguncuk allotment garden (Istanbul), and the roles of residents, civil society, and the local government in Bergen and the national and local governments in Istanbul in developing urban green infrastructures. For analyses of the Bergen and Istanbul cases, we identified statements that align with a three-governance learning typology introduced in Section Theoretical context: Governance learning, collective actions, and just adaptation. The identified statements were coded in NVivo under three thematic codes: governance learning by resisting, co-opting, and expanding. Although the interview material has mostly been important to illustrate the temporal shifts in urban climate actions and activism, we here provide exemplar quotes from our interviews (supplemented with field note-based observations) to provide a complete view of shared values and understandings about collective actions for urban green and climate adaptation and practices in the two cities. Additionally, we analyzed key policy documents to complement the qualitative interview data. The primary documents reviewed for the City Beach project are the Norwegian Planning and Building Act and the Kommunedelplan for 2019–2029. Also, the 2020 National Smart Cities Action Plan and the Municipal Law were reviewed for the Istanbul case.

Results from the case studies

Results for Bergen case

Governance learning by resisting

Learning by Resisting has not played a major role in development of climate adaptation in the Bergen case. While resistance has been a major factor in populist opposition to climate mitigation-related policies, such as toll roads, climate adaptation has not been politicized to the same degree. The first landslide attributed to climate change, in 2005, led to a significant shift internally in local governance institutions, whereby climate adaptation has been high on the agenda of the municipality (Groven, 2013; Bergen, 2019). Arguably, climate adaptation has been seen as a matter of concern for public institutions rather than for civil society activism and resistance. One exception is the special interest group Bergen River Forum, an organization based on citizens lobbying for the preservation of water streams and promotion of "blue-green infrastructure". They have primarily worked within institutional channels for this cause. However, the Norwegian governance context is one characterized by a high degree of institutionalization and public trust, and climate adaptation measures have to little extent been politicized.

Governance learning by co-opting

Public participation is inscribed in the Norwegian Planning and Building Act, so municipalities are obliged to include citizens in planning processes. In other words, there is a formal recognition of the needs for communities affected by developments to be included, and some minimum requirements for how this participation should be conducted. In many cases, local authorities exceed these minimum requirements, or use various participation experiments and activities to get particular types of input or to create legitimacy for interventions. In the City Beach Park project the municipality and invited architect offices OK Kontor and White Architects conducted a series of creative participation exercises to solicit input on the park's design. As described in a public report that produced by the municipality and the architects, the participation and co-creation activities included a drawing competition with children, a public exhibition, social media presence, an online survey and a "walk and talk" with architects for residents. There was also an online vote between five illustrated concepts for the park's design. The public vote went in favor of one concept, while the expert committee selected another—which created some controversy in the media. The University also contribute a design thinking workshop for key stakeholders in the project as part of the Horizon 2020-funded research project VARCITIES. As part of the VARCITIES project, a co-creation strategy was also designed that was intended to be implemented across the eight pilot cities of the project. However, Bergen municipality was forced to withdraw from the VARCITIES project for lack of capacity before the co-creation strategy had been implemented.

The lesson in terms of *governance learning by co-opting* is that, while the authorities are initiating creative participation activities that go beyond what they are legally required to do, substantive participation in the sense of citizens shaping proposals, is quite far off. In their own participation report on City Beach project, the municipality and its partners

conceded that practical reasons such as financing and technical limitations hindered them from taking some of the inputs into account. It is clear from our analysis that a large part of the co-creation is geared toward *informing* citizens about ongoing plan, while structural constraints make substantial participation out of reach. In an interview, a project officer from the municipality described the objective of the participation activities as "*creating an increased interest and knowledge in the population about the project we are working with, and to communicate what is going on.*" The challenge is that by the time participation processes are initiated, most of the solutions are tied up in established designs, bureaucratic processes and tight timelines. Therefore, there is very little room for the solutions that come about through participation and co-design to have any real impact on the overall design of the park.

Governance learning by expanding

The participation processes described above indicate little direct impact from participation on park design. However, if we take a broader view at the way the municipal authorities relate to voices of different communities in developing the climate adaptation agenda, there are signs of *governance learning by expanding*. Over longer time horizons and across multiple projects, authorities in Bergen are forced to take public perceptions into view. The landslides in 2005 created a strong impetus for bringing climate adaptation onto the municipality's agenda. When another landslide occurred in a neighboring municipality and one person died in 2017, and it was revealed in the media that the municipality in question did not have the required analysis and procedures in place for dealing with landslides, it caused media controversy and heightened awareness of these procedures. Local authorities did not change their procedures as a result of direct participation or citizen activism, but rather through the more diffuse mechanisms of media narratives, public debate, electoral politics and bureaucratic responsibility.

Arguably, *governance learning by expanding*, to the extent that it is observed, is in the Bergen case an evolutionary process whereby the bureaucracy, the electorate, and politicians co-produce governance agendas over time. This is not to say that power relations are equally distributed in the process. Power is held by the actors that manage to seize narratives that trigger shifts in political agendas, as for example the anti-road toll activists managed to do for the 2019 municipal elections. The Norwegian institutional context is characterized, in our assessment, both by a great deal of institutional capture as well as by high degrees of trust in governance actors. Over time, governance actors are forced to show *governance learning by expanding* to maintain this situation.

Results for Istanbul case

Governance learning by resisting

The conflict between citizens and the state through the 2013 Gezi Park resistance, triggered by state-led urban development projects vs. conserving urban green commons, was central to reconstruct the national government's narratives and actions for the urban environment in Turkey. The resistance was much more than environmental justice; it raised concerns over the oppressive regime, increasing authoritarian rule, and rapid transformation of green infrastructures for lucrative development projects. It transformed the national politics and increased state authoritarianism; criminalized environmental activism and detached the environment from political concerns while the national government mobilized itself toward urban green agendas in Turkey (Kurtiç, 2022). Accordingly, the 2018 general election slogan used "Let's Build a Greener Turkey Together" campaign conveniently preceded the announcement of snap elections of 2018, and banners along the highways of Istanbul claimed the Istanbul Metropolitan Municipality (IMM) 's success in greening Istanbul. Before the 2019 local elections, the President of Turkey opened a large urban green park in Istanbul and promised to construct new "National Gardens" in other cities. In this case, governance learning took place by which the national government was inspired by the Gezi Park Movement and integrated new policy agendas to implement urban green parks that aim to increase urban green infrastructures (e.g., tree canopy) across the country. Yet, the national government phased out the key stakeholders' participation in governance mechanisms, marginalized them, and spurred top-down urban green planning without considering local demands and climatic conditions. Thus, environmental injustices once again unfold through nationally driven urban green infrastructures in the cities of Turkey.

Governance learning by co-opting

The conflict over the Kuzguncuk allotment garden dates to the mid-1980s. The Kuzguncuk allotment garden is used as a market garden by residents of Kuzguncuk, in the Üsküdar district of Istanbul. The Directorate General of Foundations, a national institution, owns the Kuzguncuk allotment garden and the urban forestry and issued many permits to developers for public-private development projects including car-parking space, public school and a hospital from the mid-1980s till the late 1990s. The key objections against these plans were taken by a small formal local conversation group that consisted of lawyers and urban planners from the district to take legal actions against the Directorate, which successfully protected the garden and forestry for almost two decades. The 2013 Gezi Park was a milestone for the future of Kuzguncuk. The increasing authoritarian structure and lack of public input have

also fueled collective action and activism in multiple urban green commons throughout Istanbul including Kuzguncuk. Activists and volunteers organized events to gather supports from the locals to defend the green commons in the neighborhood. Activists established new associations to communicate with locals and bring support from strong NGOs in Turkey to employ several strategies to conserve the green common, while the existing formal conservation group keeps using legal channels against the national and local authorities. The increasing support from the community and the assemblage of networks involving academics, especially in architecture and urban planning departments, national and international NGOs, pushed the district municipality of Uskudar to collaborate on conserving the green common in the district. The political environment and civic actions highly influenced this decision, and the municipality accepted managing the allotment garden by regulating plots (e.g., the municipality decides to designate vacant plots to individuals for short terms). The municipality also built multiple small cottages, "knowledge hubs," for the educational and recreational purposes of the neighborhood schools. The municipality's control over the green common led to heated debates among the locals and activists about co-option. "*People from both sides were unhappy with the local governments' control and surveillance role*". *"Historically, the garden has been a place of collective action against the local and national governments' short-term economic interests."* Another interviewee added: "*This was the least desired scenario, but now at least we are happy to keep the garden status' with the local government's involvement."* The municipality showcases the Kuzguncuk allotment garden in their public relations documents and presents it as a socially responsible municipality approach with sustainability concerns. Interviewees mentioned that the activists' involvement in the decision-making had been gradually phased out, while only one neighborhood association remains as the negotiator between individuals and the municipality when disputes emerge over the designated plots in the garden.

Governance learning by expanding

In Istanbul, learning by expanding remains sidelined due to two major reasons. First, the outcomes of learning by resisting are replicated by the multiple local municipalities in Istanbul. For instance, the national government's urban environmental agenda by increasing tree-canopy in randomly selected urban vacant lands has been a favorable adaptation action for the local municipalities. Secondly, the municipalities are aware that the inclusion of communities in urban governance is not a policy coordination issue but is a political process. Against this background, the municipalities remain silent to negotiate with vulnerable urban populations' values and needs in policy creation, which exacerbates the current asymmetric power relations in urban climate governance.

Discussion

Governance learning is an emerging field and a critical aspect of environmental policy literature but is sometimes technocratic and linked to interests within formal institutional structures. Collective actions hold great potential for governance learning in terms of public participation in urban environmental planning and design. The knowledge generated by collective actions—in informal institutional settings—toward climate adaptation must be seen as a window of opportunity to transform the existing governance structures. We argue that the justice dimension of urban climate adaptation must be prioritized by decision-makers while learning from collective actions. In this paper, we broaden the concept of governance learning by integrating collective action and procedural and recognitional justice perspectives to understand better the extent to which the knowledge generated through collective actions informs governance structures to practice just climate adaptation in urban contexts**.** Two case studies, one from a small-sized city in Norway, Bergen, and one megacity from Turkey, Istanbul, guided us to understand better how decision-makers have learned from collective actions to design and adapt *in-situ* planning for just climate adaptation. Our findings indicate that governance learning by resisting is predominantly observed in Istanbul due to top-down environmental governance agenda setting imposed by the national government in Turkey on local governments. Governance learning by co-opting is found in both cases where the local governments in Istanbul and Bergen leave little space for learning from collective actions to implement climate actions. Governance learning by expanding has serious political barriers in Istanbul, whereas a few drivers might emerge in Bergen if the local government breaks the silos within the organizational structures for climate action.

Regarding governance learning by resisting the design of just urban climate adaptation, we find mixed evidence from the two cases. Collective actions for climate actions in Bergen are institutionalized, which usually means change is introduced from the local administrations for climate actions. Yet, the fixed institutional arrangements for governance learning do not necessarily lead to broader participation. There are some tensions observed between politicians with different political ideologies when it comes to implementing climate-related changes in the urban contexts in Bergen. However, collective actions for the city beach park project created a window of opportunity to bypass the political division to promote blue-green infrastructure in the city. In Istanbul, collective actions that emerged from the Gezi Park were perceived as threats to the national government. Thus, unlike in the Bergen case, the identity and capabilities of collective actions have been politically stigmatized at the national level. Such top-down pressures toward the collective action in Istanbul affected the opportunities for transforming the urban environment, excluded citizens from the urban planning, and intensified

national authoritarianism through urban environmental design. The national government marginalized collective actions, groups, and individuals, but imitated collective action activists' urban environmental agendas (e.g., creating more green spaces in cities) by exacerbating injustices and asymmetric power relations in climate and environmental governance in Turkey.

In the two cases, public participation and recognition at the local levels for governance learning by co-opting take almost similar directions. Governance learning is followed by co-opting the collective actions' ideas through the fixed governance structures. In Bergen, local governments opted for intensive participatory designs for creating a blue-green infrastructure. Nevertheless, the municipality and the private sector stakeholders hold the power of decision-making throughout the participatory processes and left little maneuvering space for activists who demanded a nature-based solution in the city. In Istanbul, however, the greater recognition and awareness toward protecting green urban areas due to the Gezi Park movement, the local government of Uskudar district opted for participatory governance, but with less involvement from the activists and more from the professional organizations in the neighborhood. Thus, instead of benefitting from collective action and evidence-based urban green implementations and consequently systemic learning for change, the municipality stands in managing the urban green common by giving little to no monitoring responsibility to the collective action's actors. The two cases clearly indicate that public participation led by public authorities for governance learning carries potential co-optation risks that the local governments exploit for further learning for just climate adaptation in cities.

Governance learning by expanding is observed in the Bergen case through evolutionary processes in which local institutions and governance structures are usually managed to address climate-related concerns raised by the locals. Norway's existing local governance networks generally recognize collective actions, groups, and individuals, and decisions makers are affected by these actions. Given that such fora already exist in Bergen, there are still silos, especially in climate planning among different organizations within the municipality (Oseland, 2019), which creates obstacles to governance learning in multi-level governance settings and to disseminating learning throughout the institutional structures. In the Istanbul case, top-level decision-makers, either in local or national governments, mainly rely on their intuition which hinders facilitating knowledge sharing with collective action actors and institutional settings within the multiple levels of local governments for climate actions. Due to the commitments toward the European directives for the local climate actions in Turkey, some local municipalities incorporate the technical language of European reports and guidelines to their local climate agendas. However, when it comes to diagnose the climate exposures in their localities, local governments in Istanbul function less effectively to initiate learning generated from the collective actions. More research is needed to understand better how governance learning triggered by collective actions is disseminated and expanded throughout the multiple layers of organizations and departments within and beyond the local governments.

Conclusion

In the Anthropocene, rapid changes in the Earth's systems generate novel problems requiring *in-situ* adaptation actions, and more research is needed to explain how collective actions through social capital or civic actions trigger governments to alter their existing governance structures through learning from these collective actions, especially in cities that are under the treats of extreme weather events. This paper suggests that collective actions through citizen and activist engagements are important sources for formal governance structures to learn how to implement robust climate actions in urban contexts. Using environmental justice (specifically recognition and procedural) and policy learning literature, we identify three learning mechanisms emerged through collective actions that may trigger governance structures to change: (1) *Learning by resisting* (formal governance structures neither recognize nor include vulnerable groups' demands in the decision-making outcomes, but come up with alternative plans influenced by collective actions), (2) *Learning by co-opting* (formal governance structures recognize vulnerable communities' needs but do not include their demands in decision-making outcomes), (3) *Learning by expanding* (formal governance structures both recognize and include vulnerable communities' demands in decision-making processes and outcomes).

There is still progress for nature-based solutions to become mainstream in planning and governing practices. From exclusively being a concept of climate change adaptation and biodiversity conservation, nature-based solutions have evolved to become a resource for environmental management. Enhancing governance learning for just climate adaptation in cities (e.g., nature-based solutions) requires collectively generated knowledge. The two case studies in the paper show that governance learning takes different directions and forms depending on the institutional contexts, the willingness of decision-makers, and socio-political environments. The governance learning typologies coupled with climate justice concerns in this paper could be beneficial for other case studies, especially to determine how climate adaptation actions foster or hinder climate injustices while urban practitioners introduce methods to develop nature-based solutions in cities.

The emerging research in climate adaptation in cities emphasizes transformative practices to identify and address asymmetric power relations in urban climate adaptation decision-making. For this special issue, we argue that

transformative practices require governance learning perspectives generated by collective actions to diagnose injustices that are emerged during the implementation of climate adaptation actions in cities. Historical injustices are exacerbated in decision-making, especially amid extreme weather events triggered by climate change. Against this backdrop, identifying governance learning pathways and their connections to climate justice (particularly recognition of vulnerable groups and their inclusion in decision-making) is essential to hinder the potential negative outcomes of climate adaptation actions in cities. Thus, we must identify what kind of learning is introduced to the existing governance structures and how that learning shapes or is shaped by the same governance structures while developing just climate adaptation policies and actions. Therefore, identifying governance learning typologies amid climate decision-making allows researchers to identify more equitable (or unequal) adaptation plans and policy developments.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Arizona State University (IRB 28356531) and University of Bergen. The participants provided their written informed consent to participate in this study.

Author contributions

MY: conceptualization, methodology, formal analysis, writing, review, and editing. HH: methodology, writing, review, and editing. LD: methodology, review, and editing. AY: supervision, review, and editing. All authors contributed to the article and approved the submitted version.

Funding

The Bergen case of this research is supported by EU Horizon 2020 VARCITIES Project (ID: 869505).

Acknowledgments

We would like to thank all the interviewees in Bergen and Istanbul for sharing their knowledge and experiences. We also would like to thank the guest editors for inviting us to submit our article to the special issue and for the workshop they organized in which we received feedback on our paper. This paper benefited from the thoughtful comments of two reviewers.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsc.2022.932070/full#supplementary-material

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frontiers | Frontiers in Sustainable Cities

TYPE Community Case Study
PUBLISHED 07 September 2022
DOI 10.3389/frsc.2022.932046

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 29 April 2022
ACCEPTED 08 August 2022
PUBLISHED 07 September 2022

CITATION
Muchiri CN and Opiyo RO (2022) Community adaptation strategies in Nairobi informal settlements: Lessons from Korogocho, Nairobi-Kenya. *Front. Sustain. Cities* 4:932046. doi: 10.3389/frsc.2022.932046

Community adaptation strategies in Nairobi informal settlements: Lessons from Korogocho, Nairobi-Kenya

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Informal settlements are often the hotspots of vulnerability as evidenced by the recurrent environmental and climate-related shocks and stressors. Despite this exposure and susceptibility, their role in spearheading disaster risk preparedness and response is often overlooked. This exploratory research profiles four local community initiatives for climate mitigation and adaptation within Korogocho informal settlement in Kenya. Findings from 10 purposefully sampled key informants and 30 stratified sampled residents across nine villages within the informal settlement demonstrated the impact of locally led initiatives in creating awareness and developing the absorptive, adaptive and transformative capacity of communities for climate resilience. The research findings elaborate on the outstanding performance of community derived initiatives, whilst putting emphasis on the need for active dialogue and collaboration between communities, policy makers and practitioners. Additionally, the climate agenda ought to be able to simultaneously promote environmental benefits and the socio-economic wellbeing of the people. This study accentuates the role of smart approaches to climate literacy based on existing community structures that leverage on local experiential knowledge. These include digital storytelling, comics, art, music, local radio stations, community opinion leaders and chief *barazas.* A key takeaway is the significant role of children in transformative climate resilience. This is facilitated by the fact that they may comprehend climate change implications better than adults augmenting the possibility of human behavioral change toward pro-environmental deeds[1].

KEYWORDS

climate shocks and stressors, disaster risk preparedness and response, collaboration, climate literacy, local experiential knowledge, community initiatives, mitigation and adaptation, transformative climate resilience

Introduction

Discussions on climate change have gained political momentum and taken the front stage among states especially with regards to deriving mechanisms to keep the temperature rise below the scientifically established tipping point of 1.5 degrees. Globally recognized pivotal initiatives in the history of climate change include United Nations

1 https://www.resilience.org/stories/2019-11-01/mind-the-climate-literacy-gap/

Framework Convention on Climate Change (UNFCCC)-1992, and its Kyoto Protocol and the COP21 Paris Climate Agreement-2015. Within Africa, there are two main policy forums that call for unity of purpose to tackle environmental concerns and climate change, namely; the United Nations Environment Assembly (UNEA) and the African Ministerial Conference on the Environment (AMCEN). Notable though is the unequitable distribution of the burden and responsibilities in response to climate change; Africa contributes just about 4% of global emissions (Forbers Africa, 2022) but stands out with a disproportionate share of lethal climatic disasters. This vulnerability is driven by the high dependency on natural resources (Reid et al., 2009) among other factors such as low absorptive and adaptive capacities, and poor diffusion of climate literacy (Grant, 2015).

In the dawn of this harsh reality, African countries have proactively mainstreamed climate change responsiveness in their plans, policies, strategies and programmes. It has become imperative to develop statutory instruments specific to climate adaptation and transformative resilience. In Kenya, for instance, the operational framework includes the Vision 2030; Ministry of Environment and Forestry, 2010; Climate Change Act, 2016; Government of the Republic of Kenya, 2018; The National Treasury, 2018; The Green Economy Strategy and Implementation Plan; and the National Climate Change Framework Policy. These are supported by institutional establishment at the national and sub national level to facilitate implementation. However, one key obstacle to meet planned milestones has been budgetary allocations amidst competing financial obligations to cater for primary socioeconomic needs. The recommended tactic is to identify and undertake local innovative mitigation and adaptation actions that unlock both climate/environmental benefits and socioeconomic dividends, simultaneously.

This perspective that has led to the emergence of novel and triumphant community-based strategies for transformational climate resilience at the neighborhood scale. This study identifies and profiles such local community initiatives in response to climate shocks and stressors within the informal settlement of Korogocho in Kenya. This community case study aims at amplifying the power of localized efforts in driving change, and the need for collaborative and decentralized urban climate governance approach (Hegger et al., 2017). This paper calls for a praxis where communities lead the process based on their needs, priorities and knowledge, with the help of policy makers and technocrats to anticipate, guide, or recover from devastating climate change impact.

The study had the following three research objectives of:

1. Assessing climate literacy and the most effective learning tools.
2. Identifying locally led climate change interventions and their contribution toward transformative climate resilience.
3. Evaluating the perceived level of collaboration among actors for climate action.

Literature review

This research examines locally designed and implemented initiatives as a pathway to inculcate climate awareness, and to transformational climate resilience. Specifically, this section reviews scholarly works that speak to locally led climate action and its competitive edge over the heavily laden and often non-inclusive top down approach. Literature on transformative climate adaptation is also analyzed to decipher the perpetual influence that community-based strategies have in reforming policy and human behavior. Imperative to driving change is community awareness on climate change. This section therefore explores innovations in imparting climate literacy. It also discusses citizen science as a tool to sensitize and engage locals in the co-production of knowledge.

Community-based perspective

Community based refers to a methodological approach in which communities actively contribute toward finding interventions to issues according to their needs and priorities (Hubberstey et al., 2015). This approach recognizes the value of local knowledge in addressing complex societal challenges in a holistic manner (Hubberstey et al., 2015). Kirkby et al. (2017) define community-based adaptation (CBA) as an approach to combating climate change through locally-led interventions that strengthen the adaptive capacity of communities. Adaptation refers to the capacity of a community to learn and adjust its responses to changing external and internal processes, while continuing to develop (Castro-Arce and Vanclay, 2020). CBA approach leads to appropriate design solutions, quicker redress to problems, greater commitment to implementation and higher beneficiary satisfaction (McNamara et al., 2020). CBA gives a voice to the voiceless by bridging the power gap inherent in a society's urban governance structure (McNamara et al., 2020).

Trundle et al. (2019) observe that community structures and informal systems are poorly understood. This is a costly oversight because building directly on locally identified priorities and decision-making processes provides a pathway for ensuring that endogenous resilience systemic traits are not interfered with. Endogenous resilience is a burgeoning concept adopted from Ziervogel et al. (2017) as *"where systems create, or build on and enhance, people's own capacity and resilience."* Trundle et al. (2019) recommend the integration of CBA and formal urban governance structures to attain inclusive and sustainable climate action.

Transformative adaptation

Transformative adaptation is an approach that identifies the fundamental causes of vulnerability to climate change with the intention of systemic overhaul in order to improve climate resilience. This is epitomized by restructuring, shifting of trajectories, innovation and persistent system wide changes to build the transformative capacity of a society (O'Brien, 2017). Transformative capacity refers to the ability of a system to initiate social transformation that moves away from untenable trajectories, toward desired ecosystem states and values (Olsson 2003 as cited in (Lonsdale et al., 2016).

Béné et al. (2012) identifies transformative capacity as one of the features of a resilience socio-ecological system, the other two being the absorptive capacity and the adaptive capacity. Similarly, Fedele et al. (2019) categorizes responses to climate change events into three namely; coping, incremental adaptation, and transformative adaptation.

According to Bahadur and Tanner (2014) transformative resilience seeks to directly confront the deep-seated political, economic, institutional and cultural processes that amplify a society's vulnerability to climate related disasters. Transformative climate action is often led by the local communities through endogenous resilience (Ziervogel et al., 2017).

Innovative climate literacy and citizen science

Literacy generally refers to competence in a specific context. It defines one's ability to understand and interpret thoughts in an informed manner as pertains to a specific subject matter (Milér and Sládek, 2011). Climate literacy qualifies one's ability to understand anthropogenic impact on socio-ecological systems (SES) leading to climate change, and how climate change affects life on earth (Mittenzwei et al., 2019).

According to Simpson et al. (2021), climate change literacy entails being aware of both climate change and one's influence on the climate system, and thus buttresses informed mitigation and adaptation responses. A person who is climate literate is able to cohesively articulate the subject of climate change. Through understanding the various dimensions of Socio-Ecological Systems, such a person is able to make informed and responsible decision aligned with environmental protection (Azevedo and Marques, 2017). The person is eager to learn more about climate, and is able to sieve through credible sources of information on the subject.

Study area and context

Korogocho is the 4th largest slum in Nairobi, located 11 km northeast of the city center (Omedo, 2010). It has a population of 36, 900 people (11, 757 households), 0.9 km^2 of land area, and a density of 42, 401 persons per sq. km (KNBS, 2019). It is located in Ruaraka constituency, Kasarani Sub-county. The settlement grew in the 1960's on government land. However, most of the parcels are now under private land ownership.

The settlement consists of nine villages, namely: Gitathuru, Grogan A and B, Highridge, Kisumu ndogo, Korogocho A and B, Ngomongo and Nyayo (see Figure 1). Korogocho is bounded by two rivers, Mathare River to the north and Nairobi River to the south, and Kenya's largest landfill (Dandora dumpsite). The housing structures are constructed from recycled materials such as corrugated iron sheets, timber, mud and natural stone and many of the residents pay rent for their houses (IFRA Nairobi, 2011). Small scale urban agriculture is a common practice despite the crowded conditions.

As part of the development programs to help improve the state of Korogocho, the Government of Kenya together with the Italian government and UN-Habitat formed a joint initiative called the Korogocho Slum upgrading program in 2008 (IFRA Nairobi, 2011), with the aim of improving the living and working conditions of the inhabitants while fostering inclusivity and capacity building (Elfström, 2021). The program has led to construction of a pedestrian walkway that links Korogocho to Dandora, an office that is used by Korogocho committee, water tanks that provide safe and healthy water for drinking, a hospital that promotes hygiene initiatives (Mbaabu, 2017), streetlights, a footbridge and a network of streets as well as a public toilet (HFHI, 2019).

Several development projects have taken place in the area through community-based organizations. These initiatives majorly aim to steer climate change literacy in the area and to help with adaptation and mitigation of the effects of climate change so as to help the community to be more conscious of disaster risk preparedness and management. Historic records of environment and climate-related disasters in Korogocho include: floods, fire outbreaks, health epidemics, droughts and famine (Owuor, 2010). Vulnerability to climate change has been enhanced by factors such as increasing population; inherent chaotic nature (poor infrastructure and sanitation); location, next to the river, and the dumpsite; socio-political marginalization and exclusion; poverty and unstable social networks, among others (Owuor, 2010).

Research methodology

At the onset, desk top reviews were conducted to gain an understanding of documented community efforts for climate adaptation and the local administrative structure in Korogocho. For this exploratory research, a combination of cluster sampling, stratified random sampling and purposive sampling method were used to select 36 respondents for the household questionnaires. In the cluster sampling, each of the nine villages were used to represent a cluster, and stratified random sampling

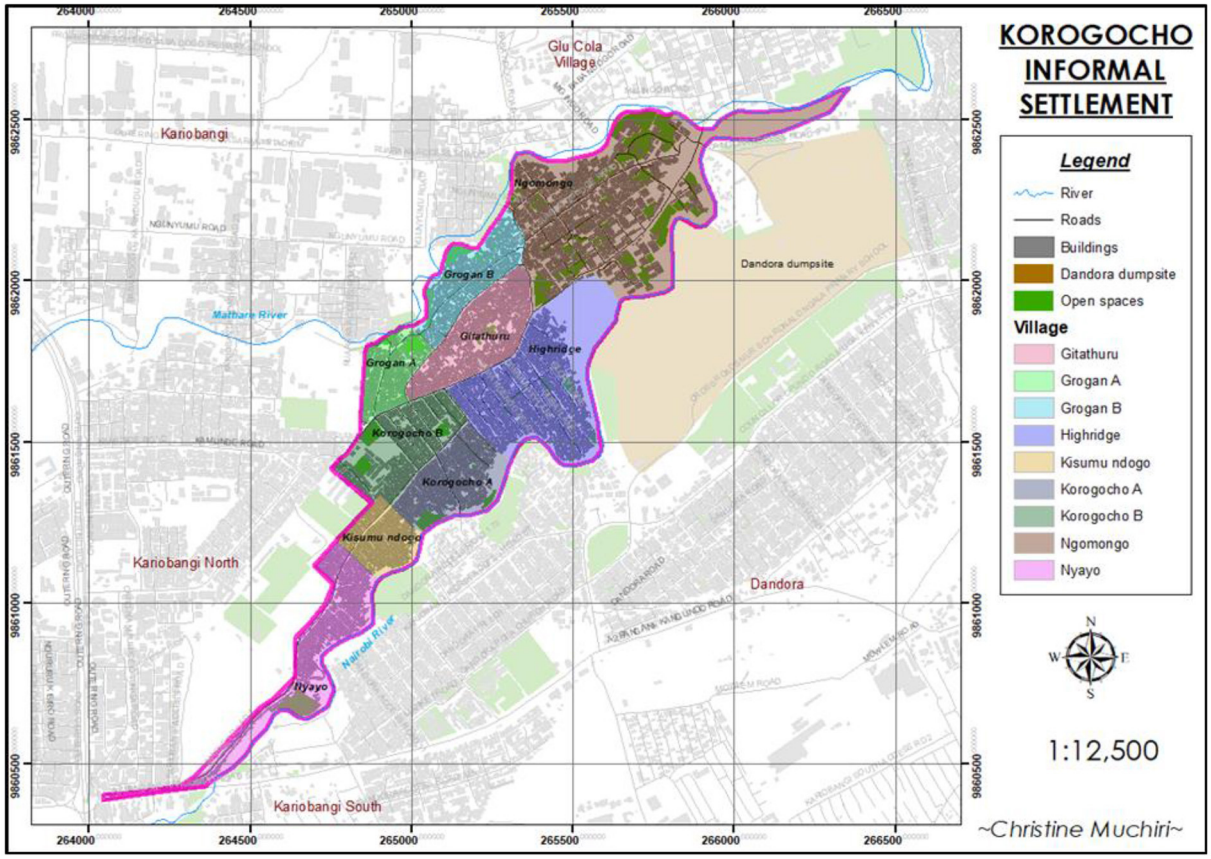

FIGURE 1
Korogocho informal settlement. Source: Muchiri and Opiyo (2022).

was used to pick three respondents from each village. The land use being mixed with both residential and commercial uses, one trader from each village was also interviewed to ensure that the data obtained was representative and accommodating of varying socio-economic dynamics. Purposive sampling was employed to select the traders. Out of the 36 administered questionnaires, six were unresponsive. Those, mostly, were cases that asked to be left to answer the questionnaires for collection at a later date. For the key informants, the research employed purposive sampling technique to reach the targeted respondents. The key informants were from Ecological justice, Hope raisers initiative, KochFM, St John's Sports Society, Korogocho Peace and Justice center, KombGreen, Daniel Comboni Primary School and the local administration and community leadership.

The household survey focused on ascertaining awareness on climate change and the best sources of information on the subject matter. The respondents also enumerated community adaptation initiatives and highlighted economic, environmental and social transformation resulting from the most influential programmes. The Key informant interview aimed at establishing the nature of relationship between the state and non-state actors in mitigating climate shocks and stressors. The key informant interview also aided in identifying the challenges faced by community led initiatives in meeting climate goals.

Four community researchers assisted in data collection. These were beneficiaries of citizen science through which the youth have developed integral data collection and analysis skills overtime. Heigl et al. (2019) highlights the role of Citizen Science as a smart tool for gathering information and initiating basic design, as well as a strategy for outreach and sensitization. Citizen Science refers to voluntary, collaborative and complementary participation by non-technical persons in scientific activities, and the process is often initiated by a scientific or academic institution (Heigl et al., 2019). This was a stimulus to the data collection process since the respondents were more responsive to familiar faces. Elfström (2021) elucidates the significant influence of digital storytelling due to its ability to appeal to human emotions and resonate with personal experiences thus compelling the audience to take action. Exploring art, theater, music, comics and peer-to-peer learning is considered instrumental in closing the education gap in the society's understanding of climate change. The University

of Brighton describes digital storytelling as a creative way of sharing a personal story through filming still images and voiceover. These films can then be streamed on the web or broadcast on radio or television. From this, the lesson learnt was that while planning for mitigation and adaptation, the interplay between innovative scientific research approaches and local experiential knowledge needs prioritization to enhance project realism, acceptability and sustainability.

Analysis was done by collating the data and coding it into different themes. The frequency of the responses was then analyzed, and patterns were drawn from it in order to generate meaningful information.

The main challenge encountered during the research was managing the expectations of the respondents who demanded to know the expected tangible outputs from the research that would substantively contribute to environmental benefits and socio-economic dividends. The research aims at increasing the visibility of the contribution of community adaptation strategies toward transformative climate resilience.

Results

- *Awareness about climate change*

All interviewees attested to believing that climate change was a reality and that their community was impacted by climate change. Their beliefs were supported by occurrences such as extreme temperatures, drought, and water scarcity, strong winds and flooding. These disasters have negatively impacted the community's quality of life. Water and food scarcity have led to high cost of living, while the air pollution has brought about emergence of respiratory diseases that sometimes culminate in loss of lives. Most respondents (40%) believed the greatest impact of climate change was the rise in the cost of living (see Figure 2). Community sources of information on climate related matters included political campaigns and forums. Some members learnt through community initiatives such as the planting of bamboo trees and global debates on various social media platforms.

- *Main actors collaborating in curbing the impacts of climate change*

The research established that while community initiatives take a leading role in creating pathways toward a climate resilient community, their efforts are supported by government ministries and agencies, international organizations and Non-Governmental Organizations. Local CBOs such as KombGreen Solutions and Hope Raisers Initiative were instrumental in raising awareness, research institutions such as African Population and Health Research Centre (APHRC) research work in collaboration with the community, International Organizations like World Food Programme offering food support to those that were severely hit by disaster, United Nations provided funds and training to help run climate adaptation related programs, the Ministry of environment and Kenya Forestry Services waste management and sensitization activities. Non-Governmental Organizations such as *Muungano wa Wanavijiji* supported the development of cohesive community structures and the Public Space Network that provided technical guidance in managing green and open spaces.

- *Community-led interventions toward disaster risk preparedness and responses*

The research sought to profile the local community organizations that had been formed over the years to prepare and respond to climate related disasters and risks. From the survey responses, a series of climate change mitigation and adaptation champions emerged including the Temple Art Youth Group, Korogocho Peace and Justice Center, Ecological Justice, Red Cross, *Ayiera* Initiative, Korogocho Response and Safety Team, KombGreen and Hope Raisers Initiative (see Figure 3).

The research further sought the opinion of the respondents on the initiatives that were perceived to be most impactful. The highest ranked initiatives were; KombGreen, Hope Raisers Initiative, *Ayiera* Initiative and Korogocho Peace and Justice Center. These four initiatives play a focal role in this paper.

KombGreen solutions

This is an environmental organization that started out as a way of providing clean water and curbing air pollution in Korogocho (Wairimu, 2020). It later became an employment opportunity for the youth who had participated in the construction of the bridge linking Korogocho and Dandora settlements, so that they would not go back to the life of crime. The youth began by clearing out the dumpsite that was next to the Nairobi River to create a space/park for relaxation. Cleaning up of the riparian was done, gabions constructed, and bamboo trees were planted, hence creating the park that was named "People's Park." Today, it offers a green space for relaxation, and an urban garden that provides vegetables to the poorest families in the area (see Figures 4, 5). The bridge is in good condition, and community members can enjoy recreation at the People's Park.

Hope raisers initiative–*Future Yetu* (our future)

To counter environmental degradation and climate related threats, the residents modeled a campaign slogan dubbed "our future, let's be responsible" in 2020, under

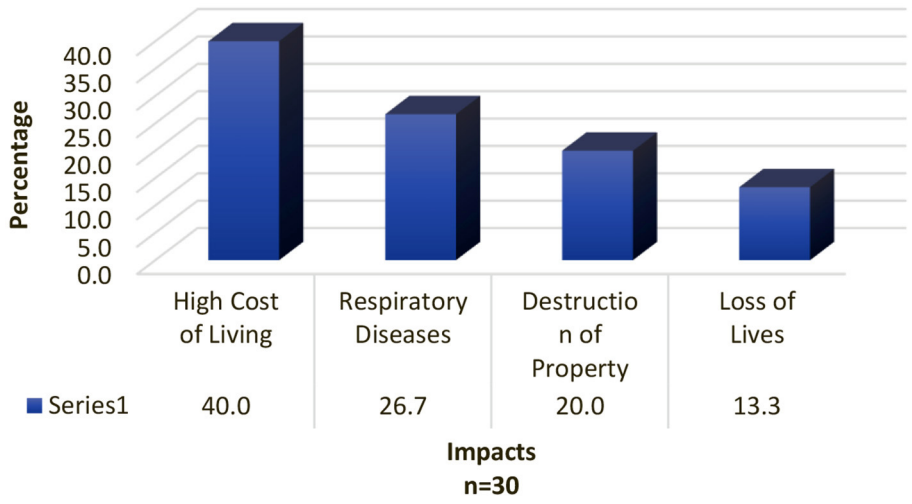

FIGURE 2
Impacts of climate change and disasters on the community. Source: Muchiri and Opiyo (2022).

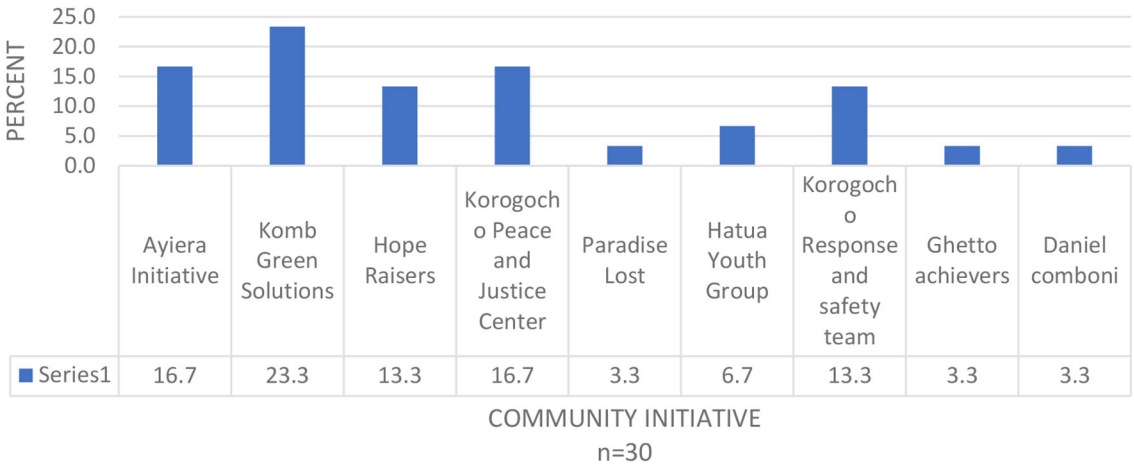

FIGURE 3
Community based initiatives that are working toward disaster risk preparedness and responses. Source: Muchiri and Opiyo (2022).

a project called *Future Yetu* (Our Future). The main goal of the project was to sensitize the residents about climate change and adaptation (Cities Alliance, 2021)[2]. Notable achievements of *Future Yetu* include: Building the communities' technological literacy; increased awareness of strong linkage between climate change, air pollution and health through a multimedia campaigns; establishing a Carbon Sink Pocket Park project at Daniel Comboni Primary School; demonstrating the utilization of free public space for green gardens; and integrating local groups into the participatory process through linkage with Nairobi County Government's Environment Department. The main outputs include forming the Korogocho Climate Adaptation Manifesto and establishing the Korogocho climate change adaptation committee.

Ayiera initiative

Ayiera was founded in 2007 as a charitable "sports for development" Community Based Organization. It aims to improve the lives of children and young people through education and talent development. Ayiera is involved in

2 https://www.citiesalliance.org/resources/publications/project-case-studies/future-yetu-digital-story-telling-climate-adaptation

FIGURE 4
Korogocho People's park. Source: Muchiri and Opiyo (2022).

FIGURE 5
Sustainable urban farming practices for food security in Korogocho. Source: Muchiri and Opiyo (2022).

awareness and sensitization on matters affecting the society to mitigate the impacts of climate change. It mobilizes residents to plant trees on the riparian reserves and in the pocket of green spaces within the villages[3]. Ayiera has kept thousands of children and youths away from the dumping site, drug abuse and crime by engaging them in activities that promote their well-being and that of the community. Locals that form membership within Ayiera are able to brainstorm and find lasting solutions to societal problems[4].

3 https://ayiera-initiative.org/

4 http://www.climatechangeeducation.org/pdf/climate_literacy_k-12.pdf

Korogocho peace and justice center

The center was established by a group of human rights defenders after assessing the community and realizing that there were myriads of social injustices that were going unpunished due to vulnerabilities affiliated with being economically disempowered. The victims either lacked knowledge on their rights or were financially incapable of contracting a lawyer. The center offers legal advice on different issues affecting the community. It tackles a broad array of concerns ranging from employment rights, accidents, child abuse/defilement, housing, land, environment, police abuse and any other human rights violation (Kituo cha sharia, 2016). A significant portion 43% of the respondents identified the works of the center as having been instrumental in creating climate literacy and providing guidance in determining mitigation and adaptation strategies.

- *Setbacks to implementing community-initiated projects*

The challenges enumerated from the survey as a deterrence to meeting climate goals include; inadequate funding to run the projects, encroachment of riparian reserves after relocation, inherent grassroot power play and cartels that frustrate certain projects for selfish gains, inadequate tools for clean-up exercises, rain-reliant urban farming and lack of water storage, lack of appropriate infrastructure for solid and liquid waste management, and poor coordination among the actors leading to duplication of projects. Despite high climate literacy levels, the culture of negligence dumping of waste was found to be the greatest setback to achieving an environmentally sound neighborhood.

Discussion

Climate literacy and locally led initiatives

From this paper, it is eminent that community-based strategies greatly influence the attitude, behavior and perception among residents. The findings indicate that embracing creative methodology such as citizen science is important in generating local interest and ownership and it is not only enhancing local climate-related literacy but also help in addressing the socio-economic concerns of the community which are rarely factored in top-down climate change solutions driven by government agencies and partners.

One cross-cutting observation from the sampled locally led initiatives is that they were framed to meet socio-economic needs, while at the same time achieving pro-environmental goals. KombGreen, for instance, was established with the aim of reclaiming the riparian reserve while creating employment for the youth who had initially been regarded as social misfits. *Future Yetu* was centered on creating climate awareness, and a

call to action for government and other partners to collaborate in combating the destructive impacts of climate change, while addressing socio-economic dimensions such as health, housing, infrastructure and income generation. Besides curbing air pollution, *Ayiera* initiative also targeted alleviation of poverty, illiteracy and social ills such as crime and drug abuse.

Community-based adaptation is seen to leverage on local knowledge to map climate change and sensitize others through similar relatable personal experiences. Notable from this research was the use of digital storytelling in the Hope Raisers Initiative as a powerful tool for imparting climate literacy.

Community-scale capacities

Welle (2014) assesses the resilience of Social-Ecological Systems (SES) at the household, community and city level. The report evaluates climate resilience through the SES absorptive, adaptive and transformative capacities. The absorptive capacity is the ability of a system to preserve and restore essential basic structures and functions in the face of climate change adversities through pre-established coping structures (Cutter et al., 2008; Béné et al., 2012). Continued enhancement of the absorptive capacity in Korogocho was exhibited through training on disaster risk by the Kenya Red Cross, saving schemes with various CBOs to mitigate climate risks and construction of gabions to offset floods.

The community in Korogocho illustrated adaptive capacity through change in planting techniques to include smart innovations such as hydroponics and vertical gardens, river cleanup exercises, and climate change awareness campaigns through print media and broadcasting. Transformative capacity refers to the ability of a system to change intrinsically in order to address the root causes of vulnerability when pre-existing conditions succumb to insurmountable adversities of climatic change (Walker et al., 2004; Béné et al., 2012 as cited in Welle, 2014). Korogocho community illustrates this through human settlement relocation from the flood risk zones, youth rehabilitation from crime and drug abuse to decent means of earning a living, and the use of solar and gas as a source of lighting and cooking energy, respectively.

Policy recommendations

Kenya has a sophisticated top-down climate policy setting which undermines decision making in local contexts thus channeling investment into unequitable and unjust programmes. The progressive development of this legal and policy framework points toward a strong political will to support climate action (Odhengo et al., 2019). However, there are a few persistent impediments that obstruct the country's climate agenda with reference to the objectives of this research. There is need to decentralize the institutional framework for climate action to befit setting of local priorities and guarantee project ownership and perpetuity.

Second is the need to make good pledges that have been made at the national level; Kenya has its revised Nationally Determined Commitments to the Paris Agreement, among other climate plans and programmes. Local communities are stepping up to take action with radical achievements such as the preparation of Korogocho Climate Adaptation Plan which superseded the Nairobi City Climate Action Plan.

Finally, in accordance with the Global Green New Deal (GGND), governments are called upon to allocate a significant share of stimulus funding to green solutions for climate action. Some counties have established County Climate Change Funds (CCCFs) but the linkage between these funds and the national system is still currently relatively underdeveloped as observed by Orindi et al. (2020). Appropriate mechanisms ought to be developed to ensure that these funds equitably and proportionately trickle down to the grassroot level particularly to the most vulnerable societies. Oversight structures for accountability and transparency are necessary to inspire the people's confidence.

Research limitations/constraints

The main constraints for this research include limitations of the concept of community adaptation, and the tools that are used to track and measure it–their narrow scope; the complexity of shocks and of systems; the relationship between climate change and environmental degradations; the fact that the methodological approach chosen is highly subjective and widely influenced by personal judgement and perceptions; and the fact that climate data at city level is scarce and mostly completely absent at neighborhood scale[5].

Conclusion

The paper concludes that locally led climate change interventions have great potential in addressing the community-felt climate adaptation priorities. This converges with the postulation by McNamara et al. (2020) that CBA promotes community approval and ownership, incorporates local realities, and catalyzes holistic foresighted planning. This approach contributes to sustainable transformative climate resilience. The study findings underscore the importance

5 https://www.unrisd.org/en/research/projects/state-of-resilience-in-africa

of collaboration among strategic partners in tackling climate shocks and stressors. The research emphasizes the role of citizen action and local politics in achieving transformative resilience at city and national level. The nexus between local experiential knowledge and impact-based scientific inputs is considered invaluable to the process of knowledge co-production. It is paramount that adaptation and mitigation measures touch on basic socio-economic factors such as food security and employment. Programmes such as waste recovery and urban agriculture for revenue generation create interest among the youth and the wider local community to champion the agenda of climate change. Additionally, the study accentuates the use of citizen science and creative methods such as digital storytelling as smart and innovative ways of building local capacities through climate literacy.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethics review and approval/written informed consent was not required as per local legislation and institutional requirements.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This work was funded by Amrita G Daniere University of Toronto Mississauga U OF T 3359 MISSISSAUGA RD UTM – OFF OF THE DEAN MISSISSAUGA ON L5L1C60000, Ontario, Canada.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 12 September 2022
DOI 10.3389/frsc.2022.933501

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 01 May 2022
ACCEPTED 08 August 2022
PUBLISHED 12 September 2022

CITATION
Camponeschi C (2022) Integrative resilience in action: Stories from the frontlines of climate change and the Covid-19 pandemic.
Front. Sustain. Cities 4:933501.
doi: 10.3389/frsc.2022.933501

Integrative resilience in action: Stories from the frontlines of climate change and the Covid-19 pandemic

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Interest in resilience and vulnerability has grown remarkably over the last decade, yet discussions about the two continue to be fragmented and increasingly ill-equipped to respond to the complex challenges that systemic crises such as climate change and the Covid-19 pandemic pose to people, places, and the planet. Institutional interventions continue to lag behind, remaining predominantly focused on technocratic framings of vulnerability and resilience that do not lead to a more robust engagement with the reality of the changes that are underway. This paper provides a blueprint for facilitating intersectional resilience outcomes that ensure that as a society we are not merely surviving a crisis, but are committing to interventions that place equity, solidarity, and care at the center of healthy adaptation and wellbeing. First, it traces the evolution of resilience from a strictly ecological concept to its uptake as a socio-ecological framework for urban resilience planning. Next, it argues that current framings of vulnerability should be expanded to inform interventions that are locally relevant, responsive, and "bioecological." The integrative resilience model is then introduced in the second half of the paper to challenge the scope of formal resilience plans while providing an entry point for renewed forms of resistance and recovery in the age of neoliberalism-fueled systemic crisis. The three pillars of the model are discussed alongside a selection of scalable and adaptable community-driven projects that bring this approach to life on the ground. By being rooted in lived experience, these innovative initiatives amplify and advance the work of frontline communities who are challenging and resisting the neoliberalization not only of urban governance and resilience, but of wellbeing and (self-) care more broadly.

KEYWORDS

climate change, healing justice, community engagement, resilience, vulnerability, urban planning, neoliberal governance

Introduction

While in the past 3 years calls for recovery and transformation have been at the heart of virtually every strategic plan advanced by governmental and multilateral actors, formal interventions continue to remain focused on outdated framings of vulnerability and resilience that are conceptually ill-equipped to address the interconnected nature of

the crises that confront us today. Scholars warn that the infiltration of neoliberal interests into the definition and operationalization of resilience does not reduce vulnerability, at best it enhances the capacity of communities to endure it (Slater, 2014; Derickson, 2018; Jon, 2021). Others caution against the coupling of resilience with social innovation, a discourse and a practice that is increasingly invoked by institutional actors eager to facilitate a swift transition to "post"-pandemic and climate-proofed futures. Premised on the idea of "disruption," social innovation has been criticized for co-opting the language of social movements to gain support for interventions that "act as a catalyst to push neoliberal policies further in society by deploying 'new ideas that work' based on a certain construction of the problem" (Fougère and Meriläinen, 2021, p. 4).

Institutional plans such as those for climate resilience and Covid-19 recovery can be considered "structures of selective attention" (Forester, 1980, p. 276) through which economic and political elites preemptively frame important concepts to pursue beneficial agendas. This subtle yet pervasive form of influence—what McCann (2017) calls "definitional power"—is consistent with Gramsci's idea of "hegemony through neutralization" (Routledge et al., 2018), a process through which the very construction of the problem determines the scope of its attendant solutions. Today, "official" resilience plans advance a strategically narrow idea of vulnerability that "collapses the political realm into the technocratic realm" (Derickson, 2018, p. 431) by reinforcing the idea that to be resilient is to "bounce back" to the status quo. As I document elsewhere, their "infrastructure-first" approach presumes that if buildings and the economy are kept safe, then residents will be kept safe as a result (Camponeschi, 2021). Similarly, because formal plans overwhelmingly exclude losses not easily quantified in monetary terms from their scope of concern, their engagement with the health dimensions of the climate crisis is marginal, particularly by neglecting to account for experiences of trauma and mental health impairment that systemic crises often entail (Cianconi et al., 2020; Cunsolo et al., 2020; American Psychological Association, 2022; Camponeschi, 2022). Institutional plans suffer from two additional shortcomings: a focus on the global scale of the problem often neglects and dismisses the local level, where lived experience manifests. As a result, institutional actors continue to advance interventions that are divorced from place-based needs and experiences, an outcome that is exacerbated by a focus on neoliberal agendas, which means that planners are often reluctant to engage residents in the project of articulating "alternative" visions for community resilience. This, in turn, results in "profound damage to democratic practices, cultures, institutions and imaginaries (Routledge et al., 2018, p. 78)." Secondly, they continue not to integrate emerging concepts such as systemic risk and planetary health into their analysis, which means that while "cities in many regions have responsibility for functions affecting population wellbeing (Sheehan et al., 2022, p. 2)" to this day there is still "no major global city climate network organized around population health outcomes and public health interventions (Sheehan et al., 2022, p. 12)."

DeVerteuil (2015) argues that violence is still "insufficiently conceptualized and disconnected from wider currents and debates in the social sciences (DeVerteuil, 2015, p. 216)," and insists we must shed light on the ways in which structural violence "acts as a vehicle to implicate the state's crucial role in health promotion or denial (DeVerteuil, 2015, p. 217)." In his analysis, violence becomes institutionalized through poverty, inequality, and discrimination, influencing collective health and preventing people from meeting their basic needs. In this sense, the selective attention of institutional plans and narratives perpetuates several forms of harm: from the "slow violence" (Nixon, 2013) that validates certain needs over those of others, to the "necropolitics" of "letting die" (Sandset, 2021). These are forms of vulnerability that do not command the same urgent collective attention as acute crises do, but are nevertheless manifestations of "ethical loneliness" (Stauffer, 2018), forms of stealth violence that arise from not being seen and heard in one's needs and experiences. The increasingly neoliberal and technocratic nature of strategic plans therefore contributes "not only to epistemological injustice, but also to very real violence played out over time as a result of any number of climate–related policies" (O'Lear, 2016, p. 7).

Whether in the face of a climate or health emergency, frontline communities play a crucial role in creating parallel structures of care that repair the harms caused by official inattention. These are communities that "do not wait for the state, or allow capital to take the initiative, but instead "negotiate with their hands" (Jon and Purcell, 2018, p. 238) to heal themselves and subverting top-down expectations of "responsibilization" (Keil, 2009) through the articulation of different values, narratives, and approaches to resilience. As I document in this paper, their organizing is truly powerful and innovative, confirming bell hooks' intuition that marginality is much more than a site of deprivation, "it is also the site of radical possibility, a space of resistance (Hooks, 1989, p. 20)." Nevertheless, their contributions continue to operate outside the formal and sustained attention even of academic researchers. Calls for radical resilience have been appearing more frequently in academic literature (Biermann et al., 2016; Fainstein, 2018; Goh, 2021), yet radical resilience itself remains undertheorized, and "we have fewer instances where those ideas are linked to concrete cases in a way that can help draw specific lessons that could be useful for planning practice" on the ground (Jon and Purcell, 2018, p. 237). Similarly, most community-engaged research is often in relation to moments of acute crisis, meaning that we are still not "able to hear the voices of those forced to live with disruption long after the disruptive event" is over (Harvey, 2007, p. 863), or learn what is required to support and sustain resilience in daily life.

In response, I couple the concept of "integrative resilience" (Camponeschi, 2022) with examples of community-driven

initiatives from around the world to: more accurately name and assess experiences of vulnerability in all of their complexity; validate the needs and contributions of frontline communities; and call for the design of "infrastructures of care" to invest in the provision of resources necessary to facilitating equitable outcomes in daily life *and* at times of acute need. I agree with O'Lear (2016, p. 5) that "reliance on grand narratives of mathematical, natural science erase or significantly discount the presence of humans and hide uneven power and social relations rooted in neoliberalism." This paper contributes to naming and identifying what is obscured and invalidated by dominant narratives of resilience and vulnerability, and offers entry points to guide the design and implementation of more equitable interventions rooted in relationality and care. Rather than following technocratic scripts organized around "innovation and the mining of hope" (Hobart and Kneese, 2020, p. 10), a focus on care and solidarity entails "a repoliticization of climate instead of the depoliticized techno-economist utopias that never deliver (Sultana, 2022, p. 2)." With an explicit commitment to amplifying practical solutions to inspire both policy change and community-engaged scholarship, this paper: (1) contributes to a more robust engagement with "radical" resilience in both theory and practice; (2) connect the dots between integrative resilience and concepts such as systemic risk and planetary health; (3) brings a much-needed focus on the (mental) health impacts of systemic risks to formal action plans, so as to expand their scope of concern beyond the context of acute crisis; and (4) offers research and policy prompts that provide the necessary scaffolding to guide the design and implementation of "multisolving" (Sawin, 2018) interventions in pursuit of healing justice. While in this paper the integrative resilience model is applied to the context of climate resilience and Covid-19 recovery, this is a responsive and scalable approach that can be leveraged in a variety of settings where adaptation, equity, and wellbeing coalesce—one that I am confident will only become more relevant in the years to come.

Literature review: The limits of socio-ecological resilience thinking

The root of the word resilience can be traced to the Latin *resalire*, which translates as walking or leaping back (Gunderson, 2010). Since the 1973 publication of Holling's (1973) paper *Resilience and Stability of Ecological Systems*, the concept has been steadily gaining the attention of academics and non-specialized audiences in a variety of settings. This interest can perhaps be explained by resilience's potential to facilitate interdisciplinary collaboration in "managing a transition toward more sustainable development paths" (Folke, 2006, p. 260). As a metaphor, resilience is also a way of thinking about the future, having a "futuristic dimension" (Manyena, 2006, p. 439) that can stimulate new forms of learning and adaptation. In its broadest sense, then, the concept can be defined primarily in one of two ways: as a desired outcome, or as a process to achieve a desired outcome (Southwick et al., 2014).

Within ecological literature, resilience has undergone several evolutions. Early theorizations of the concept assumed that, following a disturbance, nature would "self-repair" based on an implicitly "stable and infinitely resilient environment where resource flows could be controlled" (Folke, 2006, p. 253). This "engineering" view of resilience considered ecological systems as existing in a single equilibrium. In this sense, what constituted resilience was the "return time" required to bring a system back to its original state (Pimm, 1991). In later years, the concept of an "ecological" resilience was introduced by Holling (1996) to describe systems that may not return to their previous equilibrium but instead reconfigure into a different form of organization. From this perspective emerges the popular definition of resilience as the amount of disturbance that a system can absorb before tipping into a new state (Walker et al., 2004). From this vantage point, systems are not predictable and mechanistic but rather complex and adaptive. This means that they are understood to be process-dependent, with feedbacks among multiple scales influencing their ability to self-organize.

Gunderson and Holling's concept of panarchy (Gunderson and Holling, 2002) illustrates the trajectories that shape these feedbacks. Their heuristic model is composed of four phases of development: exploitation, conservation, release, and renewal. The exploitation phase is characterized by a period of exponential change that eventually leads to stasis (conservation), followed by periods of readjustment (release), and re-organization (renewal). As a set of hierarchically structured scales, the four stages are interconnected and equally important. Folke (2006), however, remarks that processes of release and re-organization have mostly been ignored in policy realms in favor of an emphasis on the first two. For example, in documents such as municipal climate plans the widespread use of terms such as "coping," "bouncing back," and return to "normal" suggests and reinforces a reactive stance to change by keeping the focus on exploitation and conservation. This translates most often into a view of resilience as the ability of social systems to withstand external shocks to their social infrastructure more than on their ability to respond to a disturbance by questioning and transforming the status quo itself. A disturbance, however, can unleash the potential for debate and transformation. For this reason, many have argued that resilience should be far more than the ability to cope or to bounce back. It should be a process that is centered around "people's aspirations to be outside of the high-risk zone altogether" (Manyena, 2006, p. 438).

As the last point alludes to, it is not just ecological systems that demonstrate resilience—individuals, communities, and nations can also organize to respond to change. Local adaptation strategies, cultural heritage, and different forms of experiential knowledge are all important factors that influence adaptive

capacity on the ground. The term "social-ecological systems" has been introduced in the literature precisely to acknowledge the role that social agents play in influencing the trajectory of resilience (Adger, 2000; Anderies et al., 2004; Olsson et al., 2004; Walker et al., 2004) as well as to stress that the delineation between ecological and social systems is "artificial and arbitrary" (Folke, 2006, p. 262).

Connecting analyses of ecological change to their interrelated social dynamics has contributed enormously to shaping the direction of climate action, particularly by recognizing cities as social-ecological systems in their own right. In their climate plans, municipalities increasingly adopt systems thinking in an attempt to account for the complexities of climate impacts. Many of them recognize that cities are linked to ecological systems across multiple scales, for example, through the production and distribution of food or the global provision of energy. They also acknowledge that cities rely on infrastructures of service delivery in order to function efficiently, as well as on networks of social agents and institutions to manage their day-to-day operations. Indeed, literature on social-ecological systems agrees on the centrality of individuals, networks, and institutions to inform the capacity of complex urban systems to self-organize, learn, and adapt. The Resilience Alliance (2010), a consortium of researchers that stimulates interdisciplinary science using resilience as an overarching framework, identifies four key factors that affect socio-ecological resilience planning at the municipal level: metabolic flows, governance networks, social dynamics, and the built environment. In its idealized form, this framework: (1) strengthens systems to reduce their exposure and fragility to ecological threats; (2) builds the capacity of social agents to develop adaptive responses; (3) creates the conditions for supportive institutional mechanisms that facilitate the ability of agents to take action, and (4) takes into account the interconnections between all the above (Manyena, 2006).

Nevertheless, many have criticized the ways in which social-ecological resilience has been operationalized in cities to date. While resilience in municipal plans is typically presented as a positive, desirable, and necessary attribute, some challenge its top-down, value-neutral rhetoric for excluding non-"expert" knowledge from formal consideration (MacKinnon and Derickson, 2012; Fainstein, 2018; Brantz and Sharma, 2020; Goh, 2021). Here, a common critique that is leveled against current resilience planning processes is that a lack of critical engagement with issues of inclusion, power, and injustice is leading to problematic policies that do not give adequate space and legitimacy to local needs and experiential knowledge (Cretney, 2014; Dubois and Krasny, 2016; Lindroth and Sinevaara-Niskanen, 2016; Angelo and Wachsmuth, 2020). Such exclusion is seen as a strategy to silence those voices that diverge from institutional understandings of (and priorities for) urban resilience planning, often exacerbating the already uneven impacts of urban development on marginalized populations (Hodson and Marvin, 2010; Middlemiss and Parrish, 2010; Jon, 2021). Indeed, while resilience has been the subject of increasing academic debate and critique, vulnerability remains an under-theorized and often misunderstood component of resilience planning. As Lebel et al. (2006) argue, at present "the discourse of managing resilience or vulnerability is subject to its own peculiar forms of politics rooted in relatively narrow ecological reasoning that has impacts on who participates and how."

Municipalities have been criticized for not adequately responding to the complexities of systemic risks by working with a limited conceptualization of resilience that largely discounts how questions of socio-economic inequality, political accountability, and community participation influence overall vulnerability (Joseph, 2013; Schmeltz et al., 2013; Diprose, 2014; DeVerteuil and Golubchikov, 2016). To assess the effectiveness and relevance of their interventions, it is therefore crucial to first understand how institutional actors frame their understandings of resilience, vulnerability, and participation. When these terms are invoked, who is seen as a legitimate stakeholder? Who benefits from formal interventions, and how are community-based needs accounted for? The next section picks up on these questions by arguing that the way that vulnerability is engaged with in institutional spaces should be expanded along "bioecological" lines to facilitate truly responsive, locally relevant, and "integrative" responses to systemic crises such as climate change and the Covid-19 pandemic.

A "bioecological" reading of vulnerability

While vulnerability and resilience research overlap to some degree, Tyler and Moench (2012, p. 317) warn that there is still "little consistency or consensus on definition" in the ways the two are engaged across several disciplines and fields. These differences are perhaps best explained by the terms' differing origin in the literature: "resilience has emerged from a positivist biophysical scientific perspective, while vulnerability has been described mainly from a constructivist social science and political ecology framework" (Tyler and Moench, 2012, p. 317). At the same time, as Watts and Bohle (1993, p. 45) argue, the relationship between vulnerability and resilience still "does not rest on a well-developed theory; neither is it associated with widely accepted indicators or measurements." As Manyena (2006, p. 439) asks, "is resilience the opposite of vulnerability? Is resilience a factor of vulnerability? Or is it the other way around?"

In the context of climate planning, for example, the overwhelming majority of municipal governments frame their action plans around a view of vulnerability that places the concept in an inverse relationship with resilience, where low resilience is believed to result in a higher degree of vulnerability and vice versa (Gallopín, 2006). Foundational to their approach is the belief that lowering exposure to natural hazards by

fortifying the built environment increases the resilience of a city as a whole, thus making it less vulnerable to climatic events. This view is reinforced by how municipalities scope their action plans: these documents commonly limit their assessment of risk to weather-related events, and typically restrict it further by focusing on the primary forms of ecological vulnerability—such as flooding and heat waves—that are identified as being most problematic for each city. Even in this case, however, institutional actors refer to hazards and risks in abstract terms, choosing to focus on their potential to act as a "stressor" or as a "disturbance" on systems and rarely with a grounded analysis of how they would affect the lives of people on the ground. To this day, most municipal plans purposefully do not take into account other forms of vulnerability and loss—such as: "more comprehensive health impacts" and personal losses—that might arise as a result of exposure to such disruptive events (see, for example, Camponeschi, 2021). For this reason, some warn that the narrow conceptualization of vulnerability as a primarily ecological matter limits the focus of municipal interventions in ways that, at best, reduce "the vulnerability of those best able to mobilize resources, rather than the most vulnerable" (Adger, 2006, p. 277).

In response, scholars of social resilience argue that any meaningful policy must be able to identify the mechanisms contributing to a community's exposure to risks and intervene to reduce the causes of social—not just ecological—vulnerability. They contend that vulnerability must be conceived of not only in relation to exposure to climate or health hazards, but also to the pre-existing "social frailties" (Manyena, 2006, p. 436) that influence local adaptive capacity. These pre-existing conditions may include factors such as socio-economic status, gender, and ability, all of which have been found to contribute to the differential vulnerability of some groups by determining access to services and forms of socio-economic support that shape and constrain the overall resilience of a community (Norris et al., 2008; Hoffman and Kruczek, 2011; DeCandia and Guarino, 2015). The role of local governments and of community organizations is therefore crucial because resilience is supported by high-capacity agents who are enabled by supportive institutions, who together determine the availability and success of prevention strategies and response services (Tyler and Moench, 2012).

Critical scholarship on vulnerability has been instrumental in bringing a more nuanced analysis to the way resilience is planned for in cities, insisting that "vulnerability is driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power in addition to interacting with physical and ecological systems" (Adger, 2006, p. 270). For some, creating mechanisms for the promotion of participatory assessments could serve as a key strategy to include the voices of marginalized populations into the resilience planning process (Adger, 2003; Krishnamurthy et al., 2011; Pringle and Conway, 2012; Wilk et al., 2018). In the fields of disaster risk reduction and public health, for example, participatory assessments are considered to be an integral part of meaningful adaptation because they help paint a more accurate picture of which subpopulations are most exposed to risk and what could in turn help mitigate their vulnerability (van Aalst et al., 2008; Pfefferbaum et al., 2015). Nevertheless, municipal governments continue to struggle to include a well-rounded definition of vulnerability in their resilience plans, and participatory assessments rarely inform the scope of their interventions. To this day, most of them also fail to provide responses that are commensurate with the multilevel impacts of systemic crises, particularly for what concerns questions of health and wellbeing. For example, municipal plans still largely do not recognize the interplay between physical and mental health, nor do they integrate "One Health" or planetary health (World Health Organization, 2017; UNFCCC, n.d.) approaches to their strategic plans. Scholars in the fields of community psychology as well as activists in the healing justice movement, on the other hand, center their analysis on an "ecological" view that directly challenges static and technocratic framings of vulnerability and resilience (Engel, 1977; Berzoff, 2011; Melchert, 2015; Cox et al., 2017).

The "ecological turn" of community psychology (Harvey, 1996) emphasizes the interdependence of individuals and the communities to which they belong. As Harvey explains (2007, p. 16): "community psychologists share with field biologists the premise that organisms live (i.e., survive, thrive, or decline) in interdependence with their environments." Rather than framing resilience as a value-neutral, technocratic process, this "resource perspective" sees resilience "as transactional in nature, evident in qualities that are nurtured, shaped, and activated by" (Harvey, 2007, p. 17) people's embeddedness in complex and dynamic social contexts "that are themselves more or less vulnerable to harm, more or less amenable to change, and apt focal points for intervention" (Harvey, 2007). This interdependence brings to life the ways in which the impacts of a disturbance do not begin and end with an individual alone but rather interact with the broader context (i.e., "ecosystem") within which they occur. As a result, the "ecological analogy" (Trickett, 1984; Kelly, 1986) can be especially powerful in the context of urban resilience planning because what constitutes an ecological threat is considered from a more expansive perspective. Rather than conceiving of disturbances strictly from the lens of environmental risks and hazards, here it's any political, socio-economic or relational factor that restricts the flow of resources between an individual and their environment that is considered a threat, because it can weaken the ability of communities to foster health and resilience among their members (Prilleltensky, 2012; Chavez-Diaz and Lee, 2015; Ginwright, 2015).

Bronfenbrenner and Ceci's "bioecological" model (Bronfenbrenner and Ceci, 1994) takes this view one step further by identifying five nested systems through which these exchanges occur, explicitly connecting them to their influence

on human health and development over time. These systems include: the biophysical (individual) level, which encompasses physiological factors that determine one's predisposition to health and resilience; the microsystem level, which is made up of the systems that most intimately and directly influence an individual's life, such as connection to family, friendship bonds, and neighborhood affiliations; exosystems such as healthcare, welfare, and education through which formal resources most commonly flow; macrosystems, which are made up of the societal norms, sociopolitics, and economic beliefs that create the larger cultural context within which resource exchanges are justified and prioritized; and, lastly, chronosystems, which reflect the trajectory of personal and collective adaptations (and their influence on health and wellbeing) over time. All five of these systems are foundational to meeting the biopsychosocial needs of individuals over their lifespan, and form the context through which vulnerability to systemic risks and the merit of resilience interventions could be evaluated in cities.

Applied to the municipal context, this view of vulnerability brings to life the ways in which successfully responding to a disturbance means going beyond economic priorities and "infrastructure-first" approaches (Camponeschi, 2021), explicitly committing to resourcing the very infrastructures of care that facilitate wellbeing, empowerment, and healing in everyday life instead. Indeed, to conceive of resilience as a process that goes beyond flood prevention or emergency medical response is a powerful way to assert that we live in a state of "shared precarity" (Butler, 2004) with one another, to acknowledge that risks and hazards do not affect only the built environment or economic portfolios but can equally impact individuals, communities, and more-than-human life. The healing justice movement discussed below has been instrumental in leveraging this bioecological lens to legitimize the needs and experiences of equity-seeking communities, advocating for the allocation of resources and the provision of services that directly nurture and expand these infrastructures of care. This is a process that entails "building robust structures in society that provide people with the wherewithal to make a living, secure housing, access good education and health care, and realize their human potential" (Southwick et al., 2014, p. 6).

The section that follows introduces the concept of integrative resilience as means of uniting these various threads into a cohesive framework for researchers and practitioners of resilience. In addition to highlighting the connections between ecological, bioecological, and social-ecological approaches, the integrative model contributes an additional dimension to the work of advancing equitable resilience outcomes by explicitly adding a trauma-informed lens to proposed municipal interventions. As a framework, it serves as a bridge between diverse disciplines and practices, and contributes to the formulation of more comprehensive policies and services that create the conditions for structural care as opposed to insisting on individualized resilience as a means (or the only means) of surviving a crisis.

The three pillars of integrative resilience

Risks and hazards are becoming increasingly systemic, meaning that their effects often ripple out to affect communities and infrastructures far beyond the point of origin of a disturbance (Pescaroli and Alexander, 2019). In under 2 years, for example, the coronavirus pandemic has made abundantly clear the many ways in which our health and wellbeing are not separate from that of people who surround us, that of the environment we live in, and that of the systems we depend on for the optimal functioning of day-to-day life. In many ways, Covid-19 has helped shift public consciousness toward a more nuanced and complex understanding of vulnerability, one that recognizes that exposure to an emerging infectious disease is not the only health hazard we face: so are poverty, isolation, and other pervasive forms of inequality that have resulted from years of neoliberal governance (Slater, 2014; Kaika, 2017). Addressing the impacts of systemic crises such as climate change and the Covid-19 pandemic therefore requires a cohesive and responsive framework that ensures that risks and opportunities are distributed fairly across diverse populations—especially in light of their pre-existing needs and vulnerabilities.

Systemic risk events reverberate and cascade across a multitude of scales, which is why responses must be multilevel as well. The integrative resilience model connects current debates about social-ecological resilience and critical urban scholarship with contributions from community psychology, trauma studies, and planetary health to call for more robust and locally relevant support before, during, and after a disturbance. The section that follows provides an overview of its three key pillars (Figure 1) to highlight their relevance and urgency in the context of resilience planning and social transformation.

Trauma-informed approach to climate planning

Climate change is increasingly recognized as a public health issue (Martinez et al., 2020; American Psychological Association, 2022). On a warming planet, researchers warn of the rise of a range of physical ailments such as asthma, heat stress, and more frequent viral outbreaks that will pose significant risks to individual and collective wellbeing in the years to come (IPCC, 2021; Watts et al., 2021). At a time of systemic crises and rampant inequality, trauma is also increasingly seen as an issue of concern for public health, in large part thanks to emerging research that is transforming our understanding of how the interplay between physiological and psychological distress can affect human health and development (Levine, 2010; van der Kolk, 2014). Nevertheless, little research exists that directly investigates the relationship between climate change and trauma. Recognition is slowly growing for the mental

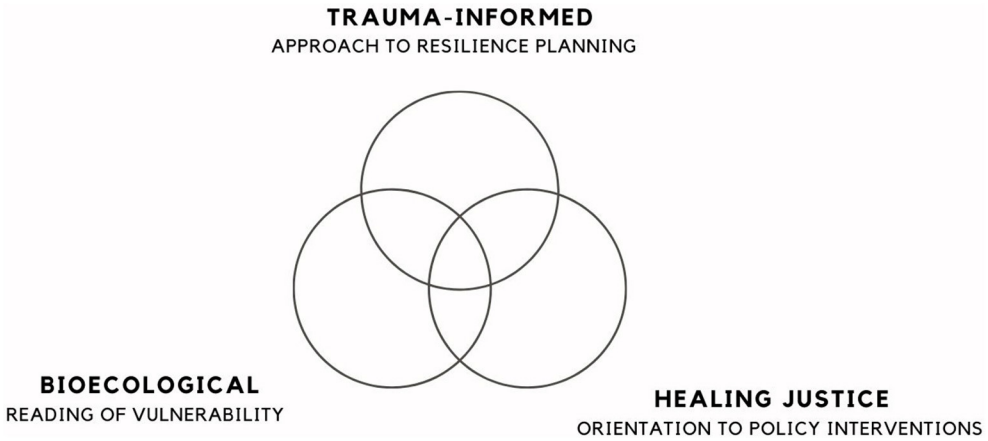

FIGURE 1
The integrative resilience model (Camponeschi, 2022).

health dimensions of climate change, particularly instances of eco-anxiety, grief, and depression that are affecting a growing number of people worldwide (Cianconi et al., 2020; Clayton, 2020). For example, the work of health geographers such as Ashlee Cunsolo has contributed enormously to exposing the reality of ecological grief and how it is disrupting attachment to place, sense of identity, and psycho-emotional health among affected communities (see, for example, Cunsolo et al., 2020).

At the same time, studies that explicitly connect climate change and trauma remain few and mostly focused on disaster recovery (Galea et al., 2005; Leitch et al., 2009; Schmeltz et al., 2013; Schulenberg, 2016). Typically, they do not acknowledge that structural inequality is in itself a traumatizing experience that can unfold not just acutely but also incrementally in everyday life (for an exception, see Paine, 2019, 2021). Similarly, when trauma is acknowledged, it is primarily treated as a personal medical experience disconnected from the broader socio-economic structures from which it originates.

Trauma-informed care is an approach that recognizes that if policy mechanisms provide uneven opportunities for healing in the population (particularly by not taking into account the bioecological nature of vulnerability) then recovery is going to be a longer, more arduous process, one that may include significant deterioration as a result of protracted exposure to stress. A trauma-informed lens is especially timely to conversations about resilience and recovery because it provides valuable guidance on how to more accurately name and validate experiences of vulnerability in all of their complexity, and helps identify invest in resources that can help to mitigate their impacts along equitable, accessible, and inclusive lines. While still a niche practice in some regards, trauma-informed care is steadily being employed to guide the provision of frontline services, particularly in the context of houselessness, sexual abuse, and addiction recovery. Its principles are also gradually gaining prominence in the public education sector, especially as more is learned about Adverse Childhood Experiences (ACEs) and their intergenerational ramifications (Burke-Harris, 2018).

Healing justice orientation to policy making

Healing justice is a small but promising field that is informing intersectional activism around the world, yet remains under-theorized and under-discussed in academic literature. As a social movement, its aim is to legitimize the needs and experiences of marginalized populations by advocating for the allocation of resources that can restore health while creating systems change (Southwick et al., 2014). At the core of this work is the view that healing is more than an act of individual self-care but rather a political process through which people and communities can reclaim wholeness and seek empowerment by tackling the root causes of maladaptive interventions (Chavez-Diaz and Lee, 2015; Ginwright, 2015). For many equity-seeking communities, the impacts of these interventions are often intergenerational, causing profoundly traumatic effects across a continuum that extends from the school-to-prison pipeline (American Civil Liberties Union, n.d.) to genetic expression (Yehuda and Bierer, 2009; Voisey et al., 2014). For this reason, healing justice advocates understand that prolonged exposure to trauma and systemic oppression not only limits a sense of agency—it also crucially undermines trust, hope, and belief in the possibility for change, thus reinforcing the status quo. As a result, they call for the design of solutions that aren't simply a one-off intervention but are rather part of a larger mandate to calibrate responses to evolving needs and shifting ecological priorities, thus repairing the disconnect between

socio-economic and environmental vulnerability that currently influences mainstream framings of resilience.

With their activism, healing justice advocates help communities and institutions "think about the diversity of caring needs and practices in our society and try to create social institutions congruent with that diversity (Tronto, 2015)." Their work also provides a bridge between bottom-up resilience planning and top-down responses, particularly by demanding a more equitable distribution of power in the interactions between communities and institutions. Indeed, because care has always been central to social movements, healing justice is inherently coalition-building work, at once an "interstitial strategy" that gives rise to "new forms of social empowerment beyond the state" and a "symbiotic strategy" of collaboration with the state, which is pushed to deepen the scope and reach of its interventions (Routledge et al., 2018, p. 80). In other words, the state "might be reconfigured to be more responsive to local or localized interventions while still providing the necessary architecture for coalition building across scales of governance and disparate geographies" (Routledge et al., 2018).

In this way, power-sharing and coalition-building have the potential to become a mediating space between institutions and residents as well as between local and multilevel scales. This dynamic interplay, in turn, allows for a departure from the status quo, allowing residents to draw from "alternative global imaginaries to bring about social, economic and environmental justice (Routledge et al., 2018, p. 84)." Through listening and power-sharing the state could similarly facilitate a more equitable redistribution of resources by supporting and investing in a "responsive architecture for solidarity and shared governance at a range of scales (Routledge et al., 2018, p. 79)," which the concept of infrastructures of care proposed in this paper represents. The latter, discussed in greater detail below, is not only a discursive form of resistance to the current 'infrastructure-first' approach espoused by most institutional resilience plans today, but is also a practical way to make those institutions more caring themselves.

Bioecological reading of vulnerability

As discussed earlier in this paper, critiques that brilliantly connect the rise of resilience planning to the neoliberalization of municipal and environmental governance are not lacking in social science literature (Keil, 2014; Angelo and Wachsmuth, 2020; Goh, 2021; Jon, 2021). At the same time, these debates still do not give adequate space to the climate crisis and its roots in neoliberal and extractivist agendas, nor to their implications for the health of the body and that of the body politic (Sultana, 2022). Similarly, in social-ecological literature, conversations that expose the links between socio-economic vulnerability and systemic risk are growing, yet recommendations for interventions do not generally advocate for systems change in a way that connects structural inequality with planetary health agendas or the demands of social movements. In contrast, the bioecological lens contributes to legitimizing and supporting community-driven approaches to resilience and recovery that, to date, remain largely excluded from formal consideration, all the while expanding the limited scope of current interventions by repoliticizing the resilience planning process.

At the heart of this repoliticization is an explicit commitment to challenging the epistemic violence inherent in technocratic discourses of resilience and vulnerability. This is a process that requires shifts in our collective imaginaries and obligations, starting with questioning "critical geopolitics of knowledge production as well as re-evaluating expertise and experts (Sultana, 2022, p. 8)." In other words, interrogating "who is invited to speak, who is heard, and who helps set agendas (Sultana, 2022)" in today's calls for resilience, recovery, and societal transformation. A bioecological reading of vulnerability helps re-centers the lived experience of frontline communities by "listening through the roars, whispers, and silences that exist (Sultana, 2022)" in today's institutional plans while taking into account the rich and dynamic needs, aspirations, and strengths of frontline communities. From this perspective, we can begin to challenge our assumptions about what causes harm, how we design our interventions, and what our benchmarks are for establishing safety, wellbeing, dignity, and health. Indeed, a bioecological lens offers alternative entry points for assessing, monitoring, and responding to the intersectional dimensions of vulnerability, in the process opening up a space for leveraging more accurate benchmarks and tools through which to evaluate the effectiveness of formal response mechanisms on the ground.

Together, the three pillars at the heart of the integrative resilience approach three pillars of integrative resilience connect disciplines and practices that have much to contribute to the conversation about transformative change but that continue to largely be kept separate in both policy and academic realms, such as: community psychology, trauma studies, care and disability studies, and more. Informed by the bioecological lens, the integrative resilience model explicitly positions trauma as a central piece (and outcome) of disruption, and is the first to connect these dimensions to a discussion of healing justice in the context of resilience planning. A healing justice orientation to the design and implementation of policies and services reveals how neoliberal values have constrained and, in many ways limited, the scope of municipal plans, calling instead for the "resourcing" of resilience through the provision of attuned services and adequate (financial, material, and relational) resources through the lens of infrastructures of care.

Nurturing infrastructures of care through structural interventions doubles as an avenue to demand the integration of wellbeing, environmental justice, and the right to the city into the very definition, process, and evaluation of resilience planning on the ground. Indeed, what makes the emphasis on healing so transformative is that if bouncing back is not the

endpoint of being resilient, but rather promoting equity and wellbeing are, then resilience planning becomes an avenue through which to ask critical questions about the push to "bounce back" to the status quo in the first place—for example, by asking which values the mainstream culture is promoting, how they play out spatially and materially, and who gets to benefit the most from them.

Combined with their already strong climate change projections and economic/infrastructural plans, an integrative approach to resilience would be a formidable complement to existing municipal climate plans. It could provide tangible tools and metrics to help keep institutions accountable and strengthen the demands of local social movements, making equity and wellbeing the primary outcomes—and standards—of successful climate adaptation. The integrative model invites policymakers, healthcare professionals, planners and other actors to consider the relational and multilevel ways in which all aspects of a community or city's life would be affected by events that they already call disruptive, working for system-level change so that policies and programs are designed with empowerment in mind rather than perpetuating barriers to access or causing re-traumatization. The second half of the paper introduces a handful of participatory initiatives that bring this model to life, providing an example of how institutional actors could, in partnership with frontline actors themselves, intervene to support, finance, and scale integrative responses in the communities they serve.

Methodology

The initiatives introduced in the next section originate from a community-placed research project that sought to interrogate how narratives of resilience and vulnerability are framed, legitimized, and circulated in cities (Camponeschi, 2021, 2022). The project aimed to understand whose experiences and interests are prioritized in formal plans and how representative they are of local needs and aspirations. To do so, it relied on an interdisciplinary approach that was grounded in mixed methods such as key informant interviews, site visits, and participatory workshops in two case study cities, Copenhagen and New York, as well as in a systematic review of their official climate action plans. This review, in turn, was complemented by a background analysis of the climate plans of an additional eight cities in Europe and North America[1] to better locate the efforts of Copenhagen and New York City within the broader context of municipal climate action.

The scope of previous articles did not allow for a dedicated focus on the contributions of the many community-driven initiatives uncovered during the course of this work—and that have continued to emerge following the Covid-19 pandemic. They are presented here in the hope of offering a concrete entry point for the work of operationalizing the integrative resilience model in cities around the world. These adaptable and adaptive interventions range from participatory disaster recovery to climate health planning, reflecting "an inherent belief in the ability of people to accurately assess their strengths and needs, and their right to act upon them" (Minkler, 2004, p. 684). In the spirit of locally relevant, community-driven processes, these cases vary greatly in their design, processes, and governance structures because they reflect the unique needs and experiences of the communities from which they originate. While faithful to the tenets, values, and aspirations of the integrative model, these initiatives also vary in their interpretation and implementation of the three pillars. Being guided by local priorities, these projects adopt an incremental approach to resilience that allows communities to swiftly respond to acute needs while continuing to draw from the "toolkit" of strategies and solutions encompassed by the integrative resilience model as needs (and multi-stakeholder collaborations) evolve over time. This is a toolkit which they themselves contribute to and enrich as more integrative solutions are co-designed and deployed by frontline communities and social movements around the world. Therefore, rather than offering a systematic assessment of these projects, the next section is intended to serve as a prompt to stimulate the collective imagination of academics, decision-makers, and other stakeholders interested in engaging with integrative resilience from a practical, not just purely theoretical, perspective. Indeed, while different in scope, these projects all share key characteristics that make them especially well-suited to an exploration of more equitable and transformative alternatives to current models of resilience planning. Together, they address structural inequality while simultaneously providing a space for biopsychosocial support on the ground, helping to keep institutions accountable while articulating stronger demands for meaningful long-term recovery and community empowerment.

Integrative resilience in action: Stories from the global frontlines

A total of six initiatives are introduced in this section. They are organized across three major categories: participatory resilience-building; community-led disaster response and preparedness; and climate health planning. The three are non-exhaustive and do not by any means capture the wide diversity and creativity that characterize emerging approaches to transformative resilience in communities around the world. Nevertheless, they have been selected for their direct relevance to the scope of this paper, which aims to discuss the contributions that the integrative model stands to make to responses to systemic crises such as the coronavirus pandemic and climate change. They have similarly been selected to represent an

1 The cities were London, Paris, Stockholm, and Rotterdam in Europe; and San Francisco, Vancouver, Portland, and Toronto in North America.

inclusive range of perspectives and experiences, particularly those that are typically excluded from, and dismissed by, formal resilience plans. Unless otherwise noted, all information about them has been sourced and cited directly from their websites and/or official reports, in a desire to let those involved in their development describe their aims and approach in their own words.

Participatory resilience-building

Northern Manhattan Climate Action (NMCA) Plan
New York City (USA)
https://www.weact.org/wp-content/uploads/2016/11/Final_NMCA_Print_UpdateNov2016.pdf

Spearheaded by We Act, an environmental justice nonprofit organization, the NMCA Plan draws from residents' experience of Hurricane Sandy to weave an integrative lens into the resilience-building process in New York City. A key premise of the plan is that "the very government definition of resilience is shortsighted, and must be expanded to include reshaping political power and erasing economic inequality." Recognizing that communities in Northern Manhattan are disproportionately exposed to and impacted by climate hazards, the NMCA Plan was co-created by residents through a participatory process that engaged hundreds of participants in seven public workshops, that were complemented by dozens of meetings with project partners and city agencies over a period spanning from January to July of 2015. Their needs and feedback directly helped shape the core ideas presented in the plan, which is structured around four key pillars: energy democracy; emergency preparedness; social hubs; and public participation. Stated in the plan is the belief that the "billions of dollars" governments and private institutions are investing in climate preparedness "should also be leveraged to address other social crises, such as chronic unemployment, poor diet, mass incarceration, and quality of education, among others." Otherwise, they warn, "the slower erosion of poverty will have the same long-term impact" on New Yorkers as climate change will. For this reason, the Plan outlines policy recommendations and informal local actions that are designed to simultaneously mitigate the impacts of environmental hazards while also addressing "the systemic inequality that has led to a disparity in political power for poor and working-class communities confronting the advancing effects of climate change" today. Solutions include the institution of community land trusts, investments in affordable cooperative housing, the facilitation of active transportation planning, the establishment of cooperatively owned microgrids, the promotion of community banking, and much more. The plan equally identifies existing municipal campaigns that are relevant and complementary to its goals, and works with local champions and municipal allies to push for more ambitious outcomes and ensure that their delivery is executed along equitable and participatory lines. Following its release in July 2015, We Act continues to work with community members and other allies to implement the plan's recommendations, which are currently being developed in partnership with local stakeholders.

Health In Harmony
Indonesia, Madagascar, and Brazil
https://healthinharmony.org
https://healthinharmony.org/wp-content/uploads/2021-HIH-Impact-Report_Final_small.pdf

Health In Harmony is an organization that works alongside 135.000 Indigenous, traditional, and rainforest peoples to protect over 8.8 million hectares of high-conservation value rainforest in Indonesia, Madagascar, and Brazil. As a nonprofit dedicated to reversing the harms of colonialism, Health In Harmony believes that the climate crisis, the extinction crisis, and the justice crisis must be addressed together. Through its Radical Listening methodology, the organization facilitates locally-designed, community-led interventions that are premised on a deceptively simple mandate: "asking communities what they need to protect their environment, [then] investing precisely in their solutions." Recognizing that "Indigenous communities are experts on planetary health," Health In Harmony acknowledges that communities "know the most feasible solutions for living in balance with their ecosystem," and that allowing them to lead not only validates and respects their knowledge and capabilities, but "helps engender a sense of trust and commitment between communities and global citizens who can help funnel resources to their solutions." As they write, working in partnership is important because "Indigenous peoples make up just 5% of the population, yet they manage 25% of the Earth's land and support 80% of the Earth's biodiversity." As an approach, their Radical Listening methodology is groundbreaking not only because it shifts the flow of resources—material, relational, and discursive—from outsider institutions to frontline communities, but because its emphasis on interdependence makes it widely applicable to many other contexts and needs. When the Covid-19 pandemic broke out, for example, Health In Harmony swiftly combined emergency medical response with a "rainforest stimulus package" to address threats to health, livelihoods and the environment. To date, the organization has conducted over 20.300 patient visits and has administered almost 4.000 Covid-19 vaccines in hard-to-reach areas while continuing to call on governments worldwide "to think about comprehensive pandemic prevention that would work at the source to stop future pandemics from happening, rather than focusing investments on simply responding to Covid-19." For this reason, Health In Harmony also partners with local and international universities to research whether "a Planetary Health/One Health approach of community-designed health, livelihoods, and conservation interventions reduces the risk of

viral spillover from animals to humans." As they write, "Covid-19 is the first of many global shocks resulting from the climate and nature crises. The results could influence conservation and development funders to eliminate silos and design more holistic approaches." To date, research into the long-term impacts of its innovative methodology has been published in the Proceedings of the National Academy of Sciences, and a new study is scheduled to be published in late 2022. In addition, the Radical Listening approach has been recognized as a Model to Address Climate Change by the WHO, and has won the 2020 UN Momentum for Climate Change Action Award, among others.

Community-led disaster response and preparedness

Community Disaster Readiness Plan
Red Hook, New York City (USA)
https://rhicenter.org/wp-content/uploads/2019/11/RHI-Hurricane-Report-6_2013.pdf

Red Hook is a neighborhood that lies on a peninsula, which makes it especially vulnerable to climatic events. 85% of its residents are Black or Latino, and with a 45% poverty rate, data indicate that Red Hook's residents are "more likely to be exposed to social risk factors, increased barriers to health care, and compounded stressors" (Schmeltz et al., 2013, p. 801). Perhaps unsurprisingly, when Hurricane Sandy made landfall in October 2012, Red Hook was one of the city's four hardest-hit neighborhoods (New York City Special Initiative for Rebuilding and Resiliency, 2013). Residents suffered severe disruptions that included lack of heat and electricity for 17 days, and lack of running water for 11 (Schmeltz et al., 2013). Subsequent studies into the impacts of Hurricane Sandy found that the major disaster plans in place at the time did not account for the impacts that "extensive and long-lasting power outages and subsequent lack of key services" (Schmeltz et al., 2013, p. 800) would have on the community. In response, Red Hook's residents developed the Community Disaster Readiness Plan to establish a locally-relevant protocol to address the critical 72 hours before and after a disaster.

The plan is part of Red Hook's Long Term Community Recovery (LTCR) process, a project of the Red Hook Coalition which received assistance from Emergency Management Methodology Partners (EMMP), and financial contributions from the American Red Cross, the Brooklyn Community Foundation/Brooklyn Recovery Fund, and the NYC Housing and Neighborhood Recovery Donor Collaborative. Informed by the experience of community members who were in Red Hook during and after Hurricane Sandy, the plan is especially mindful of the crucial period "before formal government assistance is in place," and provides recommendations for how to conduct relief operations from the bottom-up. As the initiative's website recounts: "in the first hours and days after Hurricane Sandy, the community of Red Hook organically came together and managed the initial response. Everything from wellness checks, to medical triage, to food distribution, and communications was organized by the community until disaster response and recovery workers were able to get to the isolated neighborhood." Today, residents consider this document a companion to government policies because, in addition to hurricane emergency response, the Readiness Plan acknowledges the complex reality of systemic risks and "is designed for a wide range of events including snow storms, heat waves, power outages, tornadoes, and earthquakes, among others." Upwards of 200 people were involved in its development through planning meetings and community input gatherings. At the heart of Red Hook's readiness framework are seven thematic areas that organize and distribute relief efforts across the community. These are: Support Services; Food and Shelter; Communications; Health and Medical; Community Response Team; Utilities; and Coordination. Through each of these areas, the community identifies specific locations where relief activities will be coordinated from at a time of emergency, and outlines roles and resources that will be mobilized by community members until emergency workers are able to reach the neighborhood. An example of such a role is that of Community Response Teams, which are groups of residents who perform basic search and rescue activities to locate individuals who may be trapped in place or requiring special assistance, and who deliver first aid to those in need. Another innovative feature of their plan is Red Hook Wifi, a community-based, solar-powered, free wireless internet network that residents launched during Hurricane Sandy to carry out emergency management operations and restore ongoing communications outside of the neighborhood (Cohen, 2014). Following the completion of the participatory recovery plan, the broader community was invited to learn about its contents and participate in local events that included youth training, workforce development in context emergency preparedness as well as Ready Red Hook Day, a community-wide drill, organized in 2014, that simulated an emergency scenario and acted out the guidelines found in the plan.

International Medical Corps (IMC)
Various Countries
https://internationalmedicalcorps.org/program/mental-health-psychosocial-support/

IMC is a global humanitarian organization that delivers emergency medical services to high-risk populations affected by conflict, disaster, and disease. Established in 1984 by volunteer doctors and nurses, today IMC is a nonprofit with over 7,500 staff around the world, 97% of whom are local. Their approach is rooted in a strong focus on empowerment and self-reliance, which the organization promotes by providing

community members with the skills they need to "become effective first responders themselves." In addition to their emphasis on care and engagement, what distinguishes IMC's approach is the fact that, to date, they are one of the few relief organizations that prioritizes the prevention and treatment of mental health and psychosocial needs—not just in humanitarian crises, but in global healthcare more broadly. As stated on their website, "survivors of conflict and disaster are at higher risk for psychological distress and mental health conditions, due to continued and overwhelming chaos and uncertainty, as well as the enormity of loss that often includes homes, community, loved ones and livelihoods." Recognizing that mental illness accounts for 4 of the 10 leading cases of disability worldwide and that, during emergencies, the rates of those suffering from common mental disorders can double from 10 to 20%, the organization employs a long-term strategy to help strengthen mental health care systems and shape national policies even after an immediate disaster. For example, IMC advocates for the importance of investing in adequate mental health programs at the donor, government, and policy levels. As their site reports, "only 1% of the global health workforce is working in the field of mental health today," yet "mental health is critically important to the overall health, economy and social development of whole communities and societies—not just individuals experiencing mental illness." This is of particular consequence to low- and middle-income countries, where four out of five people are not treated for mental health concerns, and where the impacts of systemic crises are felt more strongly. IMC's model is therefore especially well-aligned with the principles of integrative resilience because of a unique acknowledgment of the importance of mental health and psychosocial support before, during, and after a disturbance. Their work acknowledges the importance of relationship to both resilience-building and healing, and their psychosocial approach is closely aligned with the principles of "bioecological" human development and wellbeing advocated by community psychologists and frontline responders.

Climate health planning

Indigenous Climate Action's Healing Justice Pathway
Canada
https://www.indigenousclimateaction.com/pathways/healing-justice

Indigenous Climate Action is an organization that develops programs and resources that aim to decolonize climate policy and shed light on the ways in which climate issues are intricately connected to Indigenous rights and sovereignty. The organization's action areas are organized along five pathways that range from Gatherings to Trainings and, most recently, a direct focus on Healing Justice. As is the case for many healing justice advocates, this new pathway was informed by personal experiences of burnout and collapse experienced by ICA's leadership, who took stock of the importance of trauma-informed care in avoiding the inadvertent recreation of systems of harm that "reward hyper-productivity" within the context of community organizing. With this pathway, ICA is taking a direct stance against extractivism of all kinds by directly naming, and seeking to transform, the relational dynamics that affect personal and collective wellbeing in the work of advocating for a just future for all. As the organization writes, "in Indigenous communities, the intersection of environmental racism where homelands are destroyed, the trauma of social inequality and violence, and the constant need to assert basic rights in an unwelcoming society leads to a variety of overlapping mental and physical health challenges for many. On top of this, the culture of extraction that defines capitalism is a layer that seeps into every aspect of life—extraction on the land, akin to extraction of time, stories, knowledge, and energy—extraction as a mindset and way of being." The Healing Justice pathway complements an already rich and dynamic suite of offerings put forward by ICA, and has also been identified as foundational to its internal operations so as to bring about restorative decolonial practices and tools "that strengthen the health of our bodies and whole selves" in every aspect of what the organization does. Some of the offerings in this pathway include the Indigenous Youth Mental Wellness Honorarium, which supports the activism of younger generations by providing accessible and self-governed financial support to uplift their mental health—for example, by accessing funds to help pay for a counseling session, leave the city and "get out on the land," provide an honorarium to elders for their teaching, afford a training session, pay for a yoga class, and more. Central to ICA's vision is the recognition that "healing is climate justice" and that "rest and relationships are revolutionary." As they write, "healing is unique to each individual but also is tethered to the collective, to the communities where people work and live." Here, "communities" include non-human relatives and future generations as well, which is why the organization also actively participates in events–such as the Indigenous Economics conference, organized by the Canadian Society for Ecological Economics, or the global Talks on Trauma series-to raise awareness about the connections between anticolonial and relational thinking with healing justice, planetary health, and resilience.

Indigenous Climate Health Action Plan
British Columbia, Canada
https://www.fnha.ca/what-we-do/environmental-health/climate-health-action-program

British Columbia's First Nations Health Authority (FNHA) is the first and only provincial First Nations health authority in Canada. The organization works with local communities, government partners, and other allies to improve health outcomes for Indigenous people through a collaborative and transparent process. One of its aims is to modify and redesign

health services so that they can replace federal programs and better meet the health and wellness needs of their consituents. As part of this work, FNHA launched the Indigenous Climate Health Action Program (ICHAP) to support First Nations leadership in reducing the adverse impacts of climate change on community health. Drawing from the strength of traditional Indigenous knowledge and a relational understanding of health and wellness, the program is explicit about acknowledging that the climate crisis affects health and wellness in direct and indirect ways. The significance of this approach has also been recognized by the Intergovernmental Panel on Climate Change (IPCC), which in August of 2019 acknowledged the importance of Indigenous Knowledge in climate change adaptation and mitigation, and stated that Indigenous values play a key role in building climate resilience. The FNHA recognizes that "First Nations' deep cultural connections to the land, water and air make many First Nations in BC more susceptible to climate impacts on health and wellness." As a result, ICHAP's aim is to strengthen community resilience by "applying a flexible, community-centered approach and wholistic view of health and wellness." The community-driven projects that ICHAP funds range from a focus on food sovereignty and access to the land to mental health, traditional medicine and harvesting, and more. Even in the midst of the coronavirus pandemic, its first funding cycle successfully supported 30 projects across five B.C. health regions from April 2021 to March 2022. Initiatives included the Aboriginal Coalition to End Homelessness; Southern Stl'atl'imx Climate-Resilient Food Sovereignty Project; the Tobacco Plains Land-Based Wellness Project; and Tsleil-Waututh Nation's Climate Change and Community Health Impact Assessment and Resilience Plan[2].

Overall, the locally-driven solutions introduced in this section closely resonate with the tenets of the integrative resilience model. They place traditional and experiential knowledge at the heart of framings of vulnerability, and are explicit in centering systems thinking in the ways that solutions are conceived of and invested in. Their strong resource-centered and flexible approach helps to expand and update understandings of health and wellbeing while also shifting power dynamics and narrative framings—promoting empowerment, agency, and collaboration between people and institutions. These initiatives work transversally and incrementally to connect individual and collective wellbeing by providing access to resources, services, and programs that are "multisolving" (Sawin, 2018) and intersectional. As a whole, they provide entry points for continuing to envision, build, and strengthen those the very infrastructures of care that residents recognize as essential to keeping their health (and that of the ecosystems they depend on) resilient and thriving.

2 See their project snapshots for more: https://www.fnha.ca/what-we-do/environmental-health/climate-health-action-program/project-snapshots-202.

Nurturing infrastructures of care: Prompts for future research

This paper aimed to offer an exploratory view of how the integrative resilience model could be leveraged to rethink current approaches to resilience and recovery. While certainly complementary and equally timely, a number of questions and areas for future research emerge that did not immediately fit within the scope of this research project. For example, there is an urgent need to develop indicators that can accurately track progress on integrative resilience, particularly along biopsychosocial lines. Municipalities already collect public health data that might prove useful as a baseline for the development of resilience indicators: how might inter-departmental collaboration be spurred to refine data collection and develop new evaluative tools? Overall, how could these indicators contribute to advancing trauma-informed and healing justice-oriented policies and programs more systematically? Thinking, for example, about the links between traumatic stress and the production of cortisol (Miller et al., 2007; Bevans et al., 2008)—commonly known as "the stress hormone"—as well as insulin dysfunction (Nowotny et al., 2010; Blessing et al., 2017) and increased cardiovascular risk (Edmondson and von Känel, 2017; Remch et al., 2018), how might these biomarkers be employed to track the impacts of environmental distress and the success of resilience interventions for affected populations? How could these be leveraged not to encourage biosurveillance but to legitimize the need for better (mental) health and wellbeing support at a structural level?

Similarly, participatory processes that allow for a bioecological assessment of vulnerabilities on the ground to emerge will also be crucial, so that institutional success isn't measured solely in terms of preventing damage to infrastructure and economic activity but rather on the ability of communities to heal and thrive before, during, and after a disturbance. This process becomes especially significant for marginalized communities who are disproportionately exposed to hazards while simultaneously being at higher risk of isolation and low social support. What methodologies could best support these efforts? What opportunities are there for academic researchers to receive training in emotional first aid and trauma-informed care so as to avoid the risk of (re)traumatization when working with them?

Equally important will be supporting the development of new roles and skills around the nexus of systemic crisis and planetary health, particularly to encourage a preventative model of policymaking that can conceive of community more expansively. As Bednarek (2021, p. 23) asks, "can we include rivers, forests, mountains, salmon and viruses in our idea of community?" Thinking of care beyond the context of acute crises, what could an integrative mandate for Chief Resilience Officers look like? What other roles, departments, and

competencies might creatively be conceived of as systemic crises ramp up? At the social level, what policy interventions could facilitate culture change and break the stigma around loss, grief, and mental distress that continues to surround and influence these experiences? How to create response mechanisms that preemptively address the potential for burnout and/or "vicarious trauma" on first responders and community leaders? Similarly, further research directly exploring the climate change-trauma nexus would be especially valuable in exposing instances of environmental racism and climate injustice. It could also support the integration of community-led resilience plans such as the NMCA into official municipal frameworks, and contribute to developing participatory assessments of vulnerability from a bioecological lens. What role could academic research play in facilitating such a change?

In relation to healing justice, what opportunities are there to create spaces for healing and rest—structurally and relationally—as the climate continues to change? How could academic researchers and activists facilitate the creation of a culture of care and solidarity at a time of unrelenting economic pressure, pervasive emotional and relational disconnect, and rampant inequality? Could volatility and uncertainty about the future be used as an opportunity for connection rather than disconnection? What opportunities are there to further theorize healing justice in academic literature and participatory research? And how could healing justice be advanced without erasing or coopting the contributions of LGBTQIA, Indigenous people, and racial minorities who have contributed enormously to its conceptualization and practice?

Lastly, there is also an opportunity to keep refining the integrative resilience framework itself, particularly by conducting a systematic assessment of resilience plans beyond the ones included in this research project so as to identify common areas for intervention in academic, policy, healthcare, and activist domains. Here, a few preliminary questions emerge: How might integrative resilience contribute to our understanding (and development of) therapeutic spaces to mitigate the adverse (mental) health impacts of systemic crises and neoliberal planning? What role could public space play in organizing community responses and facilitating relational healing? And how might a healing justice perspective support community activism around the right to the city and planetary health more broadly?

Conclusion: Stimulating narrative resistance

While the early months of the pandemic seemed to reawaken an appreciation for systems thinking and bring renewed vigor to calls for climate leadership and societal transformation, the lens of crisis has continued to be invoked to reinforce a reactive stance to change, one driven by narratives of enclosure, disconnection, and austerity. Crises, however, can be richly generative moments of rupture that reveal contradictions, incite action, and stimulate new imaginaries for change. They are moments of "moral punctuation" that can be leveraged to fight back against the "anesthetizing effects (Ahman, 2018, p. 144)" of official inattention in two key ways: by "apprehending threats imaginatively (Ahman, 2018, p. 151)" and making them an "arena of creative action open to even the most historically disenfranchised groups (Ahman, 2018, p. 161)." In other words, they are galvanizing events with the potential to turn moments of crisis into moments of care.

Indeed, while neoliberal values have, in large degree, co-opted the resilience planning process in cities, for many community organizers and critical scholars resilience can still be reclaimed and redeemed. The integrative model recognizes that resilience possesses a largely unacknowledged and underestimated potential through which to articulate more robust and meaningful demands for transformative change. In particular, it points to how expanding and diversifying visions of resilience itself could double as a strategy to advance interventions that are explicit in their demands for wellbeing and justice. Experiences such as Ready Red Hook's demonstrate how a strong sense of community, belonging, and engagement can and do empower the emergence of local resilience, giving rise to "a set of networked adaptive capacities" (Norris et al., 2008, p. 135) that contribute directly to the resourcefulness of a community. In other words, it is a way to reframe resilience as more than the practice of protecting buildings and the economy but as the practice of putting relationships back at the heart of systems thinking.

To conceive of resilience not as a static or top-down process, but as a dynamic and co-created one, is one way to give rise to a critical counter-narrative that increases the visibility and contributions of marginalized communities while simultaneously facilitating stronger, more transparent policy outcomes. Narrative resistance is a practical and immediate way to co-create a different language, to circulate better stories and metaphors, and to sharpen the focus of our collective values and demands. To speak of integrative resilience, then, is an opportunity to root this work in place by creating spaces of care; an opportunity to leverage trauma literacy and healing justice to foster more meaningful relationships; and a blueprint for how to disinvest from neoliberalism's false messaging of scarcity and coping. While, on the surface, engaging with trauma may appear to be a dark and pessimistic pursuit, especially if undue emphasis is placed on experiences of deficit or loss, most trauma researchers and practitioners share the belief that this work can be a portal to healing and connection. Indeed, to speak honestly of our humaneness and our vulnerability opens up spaces for action and reflection that we have become unaccustomed to inhabiting. These spaces and practices are powerful because they point us with remarkable clarity and integrity toward what most gives meaning to life—and what resources best support living a

meaningful life. In other words, a trauma-informed lens helps urban actors better account for the multilevel dimensions of systemic crises such as climate change, allowing for the planning of policies and services that move beyond an individualistic lens of resilience and recovery, and aim instead to "foster more humanizing and transformative spaces of possibility and hope" (Ginwright, 2009).

There is an inherent pessimism in today's narratives of resilience (Kelly and Kelly, 2017). They tell us that disruption is inevitable—that we cannot really change, that at best we can return to the status quo. This pessimism, no doubt, shares its roots in neoliberalism's reinforcement of a mindset of scarcity and competition—an attitude of protectionism as opposed to interdependence, of enclosure as opposed to openness—that is pervasive and deeply entrenched in today's systems. As institutions abdicate their responsibility to constituents by falling for the seduction of the market and its promises of endless growth, one of the most devastating and alarming effects of this view can be found in the ways in which neoliberal values have infiltrated our culture and our relational models. What I refer to as neoliberal cultural violence is the expression of an economic model that places unrelenting demands on people and communities in ways that leave little room for nothing but personal survival at the expense of collective empathy, consideration for more-than-human life, as well as the luxury of time to "rest and digest" (Harvard Health Publishing, 2018). The emotional and social de-skilling that is plaguing our communities today appears to be one of the most dangerous outcomes of this form of cultural violence, as is the normalization of indifference that results from the growing disconnect and individualism that dominate our social encounters.

Neoliberalism feeds off of this atrophy of imagination. It increasingly seeps into notions of wellbeing and self-care that reinforce neoliberal patterns of consumption and individualism while diverting attention away from critical analyses of community and structural care, in so doing placing additional burdens on already marginalized populations. Planning interventions from a technocratic stance also strategically shifts attention away from questions of equity and social justice, de-emphasizing the need for a well-rounded definition and assessment of vulnerability that takes into account the already uneven effects of neoliberal governance on residents. In a society that mirrors and reinforces these pessimistic stories and beliefs rather than model attunement it becomes near impossible to imagine that there is an alternative. As Simpson (2016, p. 24) eloquently points out, "we have a government that is very good at neoliberalism and at seducing our hope for their purposes." It is no coincidence, then, that healing justice advocates see the disconnection and lack of imagination that can result from trauma as "the greatest casualty" (Ginwright, 2018) of this experience of harm.

At the heart of the integrative model is the recognition that cultivating and supporting strong relational models allows communities the opportunity to more equitably participate in the articulation of local resilience goals. As the initiatives introduced above demonstrate, on the ground resilience is more commonly seen as an opportunity to strengthen and sustain the structures of care that allow residents to continuously work toward their wellbeing and success—even if according to terms that may disrupt the economic paradigm that contributed to the disturbance in the first place. To engage in the work of healing is therefore to reclaim our agency and our right to a brighter future. My hope is that this paper contributes to sparking new public imaginaries and new conversations around vulnerability and care. I hope it helps challenge outdated and manipulative narratives of resilience and recovery, and replaces them with healthier, more emboldening ones. We shouldn't settle for anything less.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

CC: conceptualization, data curation, formal analysis, investigation, methodology, writing—original draft, and writing—review and editing.

Funding

This study was supported Trudeau Foundation and the Ontario Trillium Scholarship.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Sustainable Cities

TYPE Perspective
PUBLISHED 16 September 2022
DOI 10.3389/frsc.2022.947452

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 18 May 2022
ACCEPTED 22 August 2022
PUBLISHED 16 September 2022

CITATION
Rosan CD, Heckert M, Zerbo R and Benitez Mercado E (2022) Building a vision for more effective equity indices and planning tools.
Front. Sustain. Cities 4:947452.
doi: 10.3389/frsc.2022.947452

Building a vision for more effective equity indices and planning tools

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Recent years have seen a proliferation of equity indices and environmental justice screening tools to support more just environmental planning processes that attempt to quantify the concept of equity. While the equity index framework has proven important to advance the conversation around environmental equity and connect need to investments, we are concerned that these tools do not adequately address the intersectional nature of environmental justice concerns, effectively incorporate local knowledge on the lived experience of residents, or provide an actionable set of next steps to be taken. We see opportunities to rethink and expand on the equity index model to address issues of climate justice and preparedness through the development of Planning for Resilience and Equity through Accessible Community Technology (PREACT), a multipurpose and multi-scalar climate preparedness and neighborhood planning software application informed by both community need and community assets. This perspective article will discuss the theoretical and practical importance of adding these perspectives into screening tools and will describe our research in Philadelphia, PA aimed at understanding these challenges and developing a more inclusive and community-responsive methodology for effective tool development.

KEYWORDS

climate, equity index, green stormwater infrastructure, urban heat island, racial justice advocacy

Introduction

The climate crisis is not only a crisis of nature, but also of people, understanding, coordination, analysis, and action. Today, many of our most pressing challenges involve determining how we use information for effective decision-making and collaboration, and identifying win-win opportunities to design for inevitable climate adaptation while simultaneously meeting current needs. Data analytics and data visualization can have a significant impact on helping the public identify and respond to climate challenges, but translating data insights into visible, tangible, realistic, and effective policies with public support has been challenging, especially when trade-offs are involved and policies are untested and unproven. It's essential that we develop ways to use digital tools to better communicate the trade-offs and benefits associated with planning for climate

change. One way to do this is by working with residents to identify what support they need to both visualize existing concerns and advocate for possible solutions to make their communities more equitable and climate resilient through investments in their neighborhoods. This paper describes our preliminary findings and concerns raised while working in Philadelphia, PA, USA with a National Science Foundation Smart and Connected Communities (NSF) funded Planning Grant. Planning for Resilience and Equity through Accessible Community Technology (PREACT) works with community organizations and concerned residents in North Philadelphia through a series of working group meetings and discussions to develop a pilot model for how data and visualization tools can effectively be designed with and for communities. Though we are in the early stages of project development, our discussions so far have proved fruitful in terms of critiquing existing tools and identifying significant urban challenges that we argue that data visualization and planning tools must take into consideration to enable a truly just and equitable future.

Our research began in 2013 with the development of an equity index for Green Stormwater Infrastructure (GSI) planning (Heckert and Rosan, 2016, 2018). The GSI Equity Index was designed to identify areas of need for green stormwater infrastructure (rain barrels, pervious playgrounds, parks, trees, bioswales, green roofs, etc.) investment based on multiple factors that were informed by the current research at the time about the associated co-benefits. Our goal with the creation of the Equity Index was to push the City of Philadelphia to equitably prioritize investment of green stormwater infrastructure in neighborhoods that most needed this investment (based on a set of criteria associated with need). We used the framing of *equity* rather than *equality* to argue that there were certain communities that were lacking baseline amenities that also had more vulnerable populations. The GSI Equity Index has become one of many similar tools built to consider equitable environmental planning. However, we argue that way we approach these tools needs to be more intersectional and focused on solutions and usability.

Over the past decade, numerous indices and tools related to environmental justice have been developed to assist with environmental planning, particularly around environmental justice. Among the most prominent is the US EPA's EJScreen, which combines data on social and environmental factors to map vulnerability to environmental justice concerns (Kuruppuarachchi et al., 2017). Additional location-specific indices have been developed in Maryland (Driver et al., 2019), California (Cushing et al., 2015), and Michigan (https://www.michigan.gov/egle/maps-data/miejscreen), among others (Zrzavy et al., 2022). The development of these data and visualization tools is a vital step in the normalization of discussions of equity as part of environmental planning processes; however, our community meetings for PREACT have highlighted a series of particular challenges that must be addressed for these tools to be truly useful, effective, community-informed, accessible, and transformative. Some of these challenges are easier to overcome than others, but they warrant attention and discussion, particularly given the proliferation of data tools and the growth of big data, low-cost and accessible community technologies, and civic data.

The broad range of challenges and concerns we have identified so far include addressing the intersectional nature of environmental justice concerns, finding and incorporating all appropriate data, ensuring usability for non-technical users or those without internet access, creating accountability, addressing issues of scale, making connections to policy, and building trust with local communities. In the following sections, we will specifically discuss issues of intersectionality, data, and trust as central concerns that must be addressed to ensure just and effective planning for equity and climate adaptation.

The intersectionality of environmental justice concerns

Environmental and climate justice must be understood to be not only cumulative but also intersectional. By cumulative, we refer to the fact that multiple stressors can build on each other to produce compounding impacts. Indices are well-suited to address cumulative impacts insofar as they are additive in nature. However, the intersectional nature of some environmental challenges means that they can interact with each other in ways that are more complex and not necessarily additive (Kaijser and Kronsell, 2014; McArdle, 2021; Amorim-Maia et al., 2022). Of particular concern is the way that environmental planning might interact with existing inequalities in a manner where the solution to one set of inequalities can create or exacerbate another set of inequalities.

One key example of this is the relationship between urban greening initiatives and gentrification where greening efforts can contribute to increases in property values, with subsequent increases in rents and property taxes effectively pricing current residents out of their neighborhoods (Checker, 2011). These concerns can easily result in community opposition to greening projects, even if the greening is, in fact, desired by residents, because it is simultaneously perceived as a threat even if greening is a key component of equity and climate resilience (Immergluck and Balan, 2017; Anguelovski et al., 2019).

To enable a more intersectional approach that acknowledges cumulative and intersectional effects, equity indices and screening tools must expand beyond the typical environmental datasets to incorporate the wider range of data that speaks to the lived experiences of marginalized communities. This means that the type of equity index that we previously created which focuses primarily on greening without looking at other compounding factors, is no longer sufficient.

Many residents in low-wealth and previously redlined neighborhoods are dealing with a wide range of pressing and overwhelming day-to-day challenges, which we term "the struggle space," including, but not limited to, under and unemployment, difficulty paying rent and mortgages, accessing capital for home purchase, repairs, and weatherization, rising property taxes, evictions, food insecurity, rising utility costs, aging infrastructure, underperforming and unsafe neighborhood schools, the urban heat island effect exacerbated by a lack of tree canopy and park and recreation access, flooding, lack of affordable childcare, overabundance of vacant lots, air pollution, crime and drug use, gun violence, illegal dumping, health concerns and a lack of access to affordable housing (Rosan et al., 2021). The immediacy of many of these concerns often means that they take precedence over longer-term climate planning or projects, which can seem to communities like a waste of resources that could be better spent on more pressing needs.

Incorporating additional indicators into indices would not only enable consideration of the potential for programs to exacerbate challenges, it would also enable planning to take advantage of potential synergies. For example, there are many types of greening programs and they have different potential impacts on surrounding communities (often termed co-benefits or ancillary benefits). Greening schoolyards can provide places to play and opportunities for hands-on STEM education, while tree planting reduces the urban heat island effect, and greening vacant lots can reduce stress and gun-related violence (Dyment and Reid, 2005; Branas et al., 2011; South et al., 2015; Rahman et al., 2020). A data visualization and planning tool that also includes information on existing playground locations, health outcomes, vacant land, and gun violence would enable those factors to be considered to ensure more effective targeting of the types of initiatives that could be completed to address issues beyond the desire for specific greening outcomes.

The importance of local and contextual data

Environmental justice advocates have long argued the importance of local knowledge for effective decision-making that does not exacerbate inequalities (Corburn, 2002, 2003; Allen, 2007). Top-down planning that does not take into account the local context runs the risk of exacerbating inequalities in a similar manner to planning that does not address intersectionality.

Indices are only as good as the data behind them and the thinking about how the data intersects. Often this means they are limited to data that is collected through official channels or for entire study areas. EJScreen, for example, only includes data that is available for the entire US. Thus, demographic data is often included, but complex socioeconomic and environmental factors, as well as relevant historical information may be excluded that are nonetheless important. In Philadelphia, the initial version of our own index did not include data that we knew to exist but which was not publicly available, such as data on temperature disparities, health outcomes, and the strength of local real estate markets. Today, much of this data is also able to be collected by residents through new low-cost technologies and crowdsourced through social media platforms.

Through our work with local communities, we have identified a need for including *more* local information and crowdsourced data, such as locations prone to street or basement flooding or dumping or gun violence- problems and nuisances that build over time and cause real problems for residents, but which may or may not be regularly reported, adequately documented, or addressed by the City. Other local knowledge, such as understanding of community capacity and social cohesiveness, is even trickier to collect and operationalize and include in an index, but is still extremely important. In part because data about community capacity can be empowering for residents as well as critical to identifying policy solutions. Communities without strong internal social networks will require different kinds of support to enable successful environmental planning. The social network framing presented in some of the work on STEWMAP might be important to integrate into future iterations of the equity index to assess community capacity, particularly around environmental stewardship (Svendsen et al., 2016). Of course, local residents and community groups in each city or even different neighborhoods might also have a different way to conceptualize "community capacity" and to measure it and this will need to be explored in each community.

In addition to a more nuanced understanding of local conditions, community members also have a stronger sense of community priorities and desires than policy-makers and academics who tend to focus more at the city scale. We argue that indices should be designed to enable users to decide which factors to consider in their communities and how to weight them in order to ensure that resulting programs meet the needs of community members rather than (or, in an ideal world, in addition to) the needs of government entities or program administrators. While we recognize, for example, that a water department seeking to install green stormwater infrastructure might have a first priority of managing stormwater runoff, community residents who will live near and interact with that infrastructure will have more nuanced perspectives on what types of infrastructure they want to see given the variability in impacts of different types of projects. Residents might understand that their neighborhood lacks a safe place space and might advocate for use of water department GSI funds to create playgrounds and parks.

Addressing issues of trust and connections to policy

In a series of community zoom meetings for the PREACT project, it became clear that community distrust needs to be recognized and addressed before efforts to develop civic data tools are attempted. In Philadelphia, as in many U.S. cities, tensions between numerous universities and the surrounding Black and Brown communities are rooted in histories of displacement, gentrification, structural racism, elitism, and even the previous mismanagement of environmental projects. As a result, when academics and/or government officials talk with residents about planning for climate change, or helping them co-design data tools that promote "justice or equity," residents have justifiable trust concerns: (1) why are they being asked to engage in these conversations? (2) how will thinking and talking about neighborhood concerns or prioritizing future climate investments address their day-to-day concerns?; (3) how is local knowledge and expertise being acknowledged, rewarded, and mobilized?; and 4) do government officials and/or academics really understand or care about their struggles? Residents are reluctant to be involve in yet another academic planning process that might bring in large dollar amounts and prestige to university researchers, but does not tangibly change community conditions. In addition, planning processes that ignore concerns about displacement and gentrification and the power dynamics associated with government and university researchers are seen as contributing to these negative outcomes.

We are not unique in observing issues of trust as central to effective environmental planning, and that relationships take time to build (Boschetti et al., 2016). However, we argue that many tool developers and mappers underestimate its importance. In fact, our observation in our research is that "collaboration moves at the speed of trust." The vision we have laid out for an intersectional and locally responsive tool, however, cannot be achieved without meaningful, sustained participation by local residents and open and thoughtful discussions about how to overcome trust challenges. Trust is also essential for the long-term usability and sustainability of the tool itself. In fact, in our work, we have been brainstorming the possibility of creating a non-profit that is community controlled that ultimately takes over ownership and responsibility for managing the data and planning tool.

Closely related to issue of trust is the concern that tools are more effective at pointing out problems than identifying solutions. To be used meaningfully by community members, the data tools and visualizations we build with communities must connect data to action (Williams, 2020). It is not enough to be able to craft a story about cumulative impacts of multiple environmental stressors if that story remains in the tool or circulates only within the community itself. Furthermore, a tool that only highlights known challenges without offering solutions or connecting to policy solutions runs the risk of alienating or disheartening communities rather than empowering them. We believe that incorporating explicit community identified next steps and solutions will be crucial for building necessary trust that this tool is more than just an exercise but is intended to promote meaningful change in communities.

Discussion—Our vision for a more responsive and integrated tool

All of this lays out a framework where equity indices, though valuable, do not do enough in their current forms to truly lay the groundwork for a more just and equitable climate ready future in which vulnerable communities are empowered to fight for necessary community improvements without risk of displacement. We see tremendous promise in the proliferation of these tools, but see a need for considerable refinement of existing technologies and more robust community engagement processes so they can be designed for more than a narrow set of users and use cases. We believe that such a tool is possible to create, but that it cannot be created without centering the communities that it seeks to serve.

Though we are still in the early stages of planning for the PREACT research project in Philadelphia, we have already identified a range of key concerns that can help guide future efforts at equity index development and community-based environmental planning. Ultimately, our insistence that local context and community needs matter means that there is no one set of easy solutions or one specific workflow that will solve all problems. Instead, there is a need for a flexible and extendable framework of collaboration that can be built out to take an expansive, intersectional approach to understanding cumulative impacts and environmental risks. And this framework (which is as much about building trust and understanding and relationships as it is about layering data into a software and mapping tool) must be deployed in a manner that builds trust and empowers communities to act as agents of change in shaping future developments.

To include hyper-local characteristics of individual communities when gathering data, it will also be necessary to design the tool with the digital divide in mind. As the PREACT project progresses and the software tool is created, community training and feedback will also be critical. We will host community events and meetings where residents can practice using the tool to both view currently displayed information (and give feedback about how representative it is) and develop the skills necessary to upload information to the tool. These events will also serve as spaces where project partners and participants can share information relevant to the tool's effectiveness and the ability of the tool to highlight their lived experience. These events will also serve to support impacted residents that would not otherwise have the time and access to work on computers or focus on proactive climate planning for their communities.

Project partners will also individually meet with residents and participate in existing community events to solicit input on the project, advertise it, and assist residents in documenting their lived experience and their desires for a more environmentally functional existence.

By viewing the creation of equity indices as a process of building trust and relationships among researchers, policy-makers, community advocates, and community residents, we argue that we can better meet the challenges of solving complex and intersectional problems with equity indices, data and visualization tools. What is exciting is that we have the data and increasingly have cost effective ways to gather hyper-local data. But the data needs to be useful for changing the way that we think about the problem definition and the solution space in communities. To allow that to happen, we suggest that creators of equity indices and data visualization tools invest deeply in their relationships with community residents to understand and address their concerns. Through careful listening and deliberative dialogue with communities, researchers and data visualization specialists can better develop more authentic and useful planning tools and equity indices that can identify community need and policy-pathways for equitable climate investments.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

The paper was broadly conceptualized by CR and MH. Written jointly by CR, MH, RZ, and EB. All authors contributed to the article and approved the submitted version.

Funding

Funding from the National Science Foundation Smart and Connected Communities Planning Grant (Award number 2125375) supports the development of Planning for Resilience and Equity through Accessible Community Technology (PREACT).

Acknowledgments

The authors would like to thank all the community members, government officials, non-profit leaders, and advocates who have been a part of on-going conversations and workshops about how to develop the GI Equity Index and PREACT. Earlier work on the GI Equity Index was supported by an EPA STAR Grant (R835555). Opinions, findings, and mistakes are not endorsements by the EPA or the NSF and are entirely those of the authors. Thank you to Sarah Williams and research support from Wesley Woo, Naida Montes, Kermit O and Kevin Wang.

Conflict of interest

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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frontiers | Frontiers in Sustainable Cities

TYPE Perspective
PUBLISHED 26 September 2022
DOI 10.3389/frsc.2022.956534

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 30 May 2022
ACCEPTED 29 August 2022
PUBLISHED 26 September 2022

CITATION
Wolff E, Rauf HA, Diep L, Natakun B, Kelly K and Hamel P (2022) Implementing participatory nature-based solutions in the Global South. *Front. Sustain. Cities* 4:956534. doi: 10.3389/frsc.2022.956534

Implementing participatory nature-based solutions in the Global South

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This article delves into the participatory aspects of the implementation of nature-based solutions (NbS) in the Global South. It examines the practices of community engagement in several projects conducted in informal settlements and how they relate to project visions. Building on previous work on community engagement for urban upgrading projects, we examine the relationship between the methods used to engage communities and the goals that guide the design and implementation of NbS. In doing so, we explore engagement practices that can support the emergence of transformative approaches in historically disadvantaged areas. We discuss how the degree of participation offered by different methods, such as citizen science and serious games, can substantially influence the outcomes of NbS projects by making them more integrated and site-specific. We conclude by discussing how the transformative implementation of NbS entails a multi-stakeholder proactive approach that is capable of supporting changes in the socio-ecological systems.

KEYWORDS

participatory methods, nature-based solutions, Global South, transformative, informal settlement

Introduction

Nature-based Solutions (NbS) have been gaining attention in the context of urban "upgrading projects" in informal settlements in the Global South (Cohen-Shacham et al., 2016). Ranging from raingardens to green roofs, tree planting or mangrove restoration initiatives, these projects have multiple functions including producing food, providing cultural value and serving as public space. In the context of informal settlements, areas historically characterized by reduced access to infrastructure and services (UN Habitat III, 2017), NbS have been framed as important strategies capable of mitigating some of the impacts of climate change such as heat waves and flooding (Sengupta, 2016; French et al., 2020; Sattherthwaite et al., 2020; Rauf et al., 2021).

The recent literature on experiences with NbS in the Global South indicates that community gardens and tree planting efforts are common, but community participation is still incipient in most informal settlement "greening" initiatives (Puskás et al., 2021; Kiss et al., 2022). While this trend is similar to that in wealthier urban centers, where NbS projects are still too rarely co-designed with local residents (Frantzeskaki, 2019; Kiss et al., 2022), there are challenges and controversies specific to the informal settlement context. Reflecting on those, several authors have warned against NbS-centered upgrading initiatives for reproducing unequal power relations and exacerbating existing vulnerabilities (Cousins, 2021; Kotsila et al., 2021; Seddon, 2022). While the literature indicates an interest to involve the communities in the implementation of NbS, examples of successful and just community involvement in the design of NbS in the Global South are still rare (Gouverneur, 2014; Das and King, 2019; French et al., 2020). This Perspective paper presents such examples and insights into how participation and project vision (the goals, values and expected outcomes that guide each initiative) are intertwined in NbS projects in informal settlements.

Transformative development of NbS in informal settlements entails discussions about institutional, social and ecological systems (Diep et al., 2019; French et al., 2020). The term "transformative" here refers to the reorientation of society's capacity toward proactive, transdisciplinary, multi-stakeholder initiatives that foster the development of novel solutions (De Graaf-van Dinther and Ovink, 2021). Transformative development should be guided by the fair distribution of benefits and risks (Mcmillan et al., 2021) as well as the prioritization of local livelihoods, including systems linked to food production and income generation. This is only possible by supporting institutional changes and acknowledging social and ecological processes within the settlements "through broad participation, including traditional, local, and scientific knowledge, as well as the distribution of benefits in a fair and equitable manner" (Cousins, 2021, 6).

The participatory ladder is a model for analyzing participation within informal settlement upgrading projects. Based on Sattherthwaite et al. (2020)'s reflections on housing and infrastructure-provision initiatives, the ladder identifies approaches that range from non-participatory, tokenistic and exploitative projects to highly collaborative, community-led efforts. While this framework provides a useful tool to evaluate the institutional aspects of upgrading projects, it assumes that higher levels of participation necessarily lead to more successful projects as it does not directly reflect on how participatory approaches affect goals, values and expectations throughout the project. In the context of NbS implementation, we consider that Sattherthwaite et al.'s ladder is insufficient to analyse an aspect essential to transformative initiatives: the social and ecological relationships that underpin NbS in informal settlements.

Participation and project vision underpin transformative approaches to nature-based solutions

Expanding Sattherthwaite et al.'s ladder, we argue that the transformative potential of an NbS is not only determined by the participatory approach used but, more importantly, by how this approach can transform the project vision and ensure that the NbS can be integrated with the local needs and environments. This is important because common types of NbS in informal settlements (including wetlands, green areas, and community gardens) are inevitably intertwined with social and ecological dimensions by providing services such as food production and income generation as well as playing cultural and spiritual roles in their contexts (Hamel and Tan, 2021). As such, transformative initiatives should be informed by socio-ecological systems and guided by the willingness to revise project's goals, values and expectations during the design and implementation of NbS.

There is a spectrum of community involvement in the implementation of NbS in informal settlement upgrading projects, ranging from non-participatory to transformative approaches (Figure 1, left-hand side). In parallel, there is a spectrum of ways in which NbS projects consider local needs and environments, represented by the categories of "project visions" ranging from initiatives that only replicate foreign initiatives to projects that are highly integrated with local social and ecological relationships (Figure 1, right-hand side). Combining these two elements suggest that projects with low levels of community participation generally lead to the replication of solutions developed in other locations. This is particularly challenging since informal settlements and their relationships with their surrounding contexts can vary significantly and, for this reason, require different approaches (Mulligan et al., 2020). On the other side of the spectrum, projects that strive for a transformational practice and deep community participation will lead to NbS being well integrated to the socio-ecological contexts. In the following, we illustrate the different levels participation and implications for project vision with examples from the literature and the authors' own experience.

From non-participatory to manipulative approaches

Despite the importance of community participation, many projects still operate according to a non-participatory or manipulative approach that uses engagement activities as a platform to impose or convince local stakeholders to agree with plans to replicate NbS from other contexts. While these projects may be guided by well-intended experts, minimal opportunities for critical discussions within the decision-making practices can lead to lack of transparency and to an unequal distribution

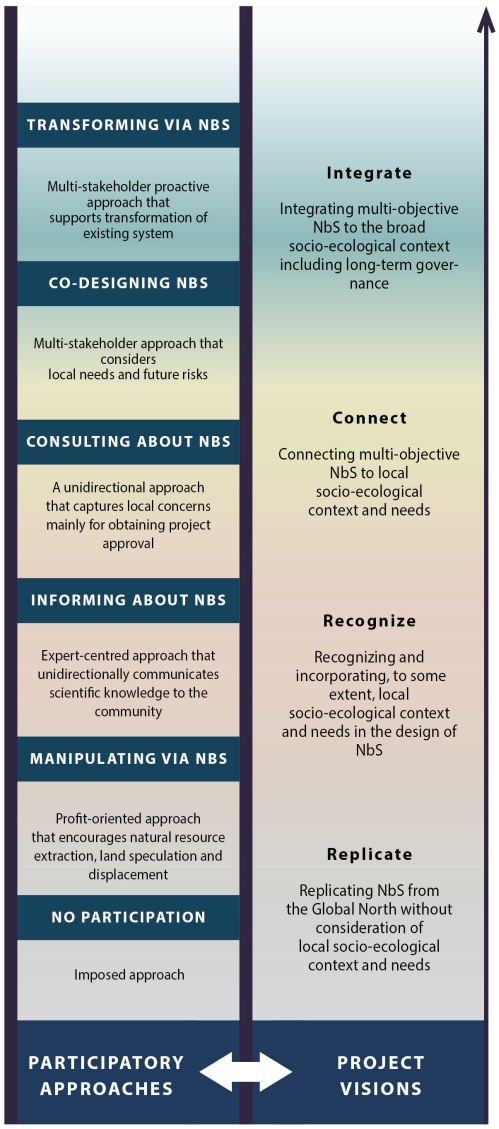

FIGURE 1
The relationship between participatory approaches and project visions for the implementation of NbS in the context of informal settlements.

of benefits and risks. The controversial implementation of the "Room for the river" strategy developed in the Netherlands in several megacities in Southeast Asia serves as an example of this situation (Yarina, 2018).

In an effort to "climate-proof" coastal megacities, local governments often relied on international expertise to "upgrade" urban waterfronts in Southeast Asia. Several proposals for the future of Jakarta, for example, replicate Dutch infrastructural systems using a combination of NbS, dikes and concrete embankments (World Bank, 2019). These projects have led to mass eviction and displacement of local residents of informal settlements (Yarina, 2018). These residents are perceived as the root causes of the land subsidence and their presence is framed as a hinderance to the success of the riparian revegetation projects proposed (Padawangi and Douglass, 2015; Goh, 2019). Often privately funded, projects with low levels of participation have been denounced for often resulting in to land speculation and for not prioritizing the most vulnerable communities in the city (Goh, 2019).

From informative to consultative approaches

To achieve a higher degree of participation, most projects implementing NbS in informal settlements now claim to employ informative, consultative or co-designed approach (Melanidis and Hagerman, 2022; Seddon, 2022), recognizing the limitations of simply replicating an NbS from another context.

Informative approaches are still primarily centered on external experts but indicate a recognition of the need to communicate with communities to anticipate gaps in the implementation. *Consultative approaches*, often prompted by an institutional requirement to consult the community, represent a transition between initiatives that recognize local contexts and initiatives that start to connect site-specific aspects in the design of NbS. This degree of participation requires platforms for communications: workshops, focus groups, surveys, and more recently "serious games", which can connect with local livelihoods in projects addressing the needs of residents of informal settlements.

Serious games are defined as games to engage communities to deliver specific objectives (e.g., pedagogical, or problem-solving purposes) and operating beyond the realm of entertainment (Abt, 1970). In the case study of Kin Dee You Dee ('Eat well, live well') in Thailand, serious games have have been used to engage local communities in the discussion of climate change adaptation strategies (Marome et al., 2021). The experience revealed that serious games can serve as a method to sensibly consider local needs in the context of informal settlement upgrading projects. Residents who engaged with serious games expressed acquiring new knowledge that encouraged climate preparedness (Marome et al., 2021). While indicating that the use of games gave them more space to co-design collective solutions, the residents also expressed that this method offered opportunities to connect adaptation strategies to their values and immediate needs. This example demonstrates that the implementation of informal settlement upgrading projects requires the creation of "safe space" that can offer visibility to underrepresented livelihoods (Marome et al., 2021).

In this case study, while serious games were primarily used for co-identifying individual and collective assets (e.g., financial

assets, infrastructure and services, and natural capital) they also offered a platform to discuss urban farming options by exploring the perceptions of the residents toward their environments. This approach gave researchers a better understanding of what NbS, such as green spaces, meant for local livelihoods and whether they are regarded as valuable communal assets or not. The findings show that planting vegetables were commonly recognized as a strategy to improve food security and diversify income sources through new planting techniques such as hydroponics (Archer et al., 2019). This suggests that the use of serious games could be applied to overcome epistemological differences and create opportunities to discuss NbS as valuable strategies aligned with the needs of local stakeholders. In brief, such participatory platform could aid in facilitating more inclusive and equitable NbS implementation, and contributes to the active community of practice working on approaches and tools to engage residents of informal settlements as active agents in the design of local solutions (Toxopeus et al., 2020; Tozer et al., 2020).

From consultative to co-designed approaches

Innovative engagement practices, such as citizen science, can create opportunities to expand consultative projects by engaging residents in discussions about NbS that would otherwise be restricted to experts. The term "citizen science" is commonly used to refer to initiatives that "invite" non-scientists to participate in research activities such as monitoring biodiversity, temperature or water level variations (Haklay et al., 2018). The use of citizen science as part of a co-design process is not meant to be unidirectional but, instead, an approach that acknowledges communities as proactive actors in understanding future scenarios and preparing for climate adaptation. *Co-design approaches* in this context, allow multiple stakeholders to plan for uncertain future conditions by integrating local priorities and existing everyday challenges in the design of NbS.

Co-design approaches are characterized by the involvement of multiple stakeholders in ways that require deeper commitment and negotiation in the development of projects. One example of the use of this engagement practice in the design of NbS was developed within the Revitalizing Informal Settlements and their Environments (RISE) program, an initiative constructing wastewater-treatment wetlands in informal settlements (Brown et al., 2018). The constructed wetlands in RISE serve as an example of a NbS with a single objective (to address water contamination) that was further expanded as a result of the use of a co-design approach (French et al., 2021). As part of the engagement practices, the program used citizen science as a platform to involve communities to participate in the design of NbS.

In this program, researchers conducted a flood-monitoring project in partnership with communities living in informal settlements to inform the design of NbS (Wolff, 2021). Residents acting as citizen scientists collected photos of floods that helped researchers within RISE to better understand the local hydrology in the peripheries of Suva (Fiji) and Makassar (Indonesia). Between 2018 and 2020, this project collected a comprehensive archive of more than 5,000 photos of flood levels that informed the design of the constructed wetlands (Wolff et al., 2021). This project illustrates that, while co-designed approaches allow a deeper engagement with communities it also introduces new responsibilities that need to be negotiated with participants.

Beyond the dataset, interviews with the residents also suggested that the use of citizen science created opportunities for residents to proactively reflect on local floods and upgrade their houses accordingly. This case study reveals that co-designed approaches require more time and resources to engage the communities but, in turn, can lead to more transformative ways of designing and implementing NbS beyond single objective goals by responding to local needs and priorities (ADB and RISE, 2021).

Toward transformative approaches to NbS in informal settlements

In contrast with approaches that only seek to engage local communities through informative engagement practices or consultation, transformative approaches should strive to integrate NbS with the local needs and priorities, including long-term governance. Engagement practices that support the understanding of socio-ecological relationships are important in the contexts of informal settlements as they acknowledge the complex nature of the relationships established by the local residents with their environments. A deeper integration of NbS with social and environmental context is key to avoid polarizing views that frame NbS, such as riparian revegetation or tree planting, as barriers to addressing the needs of local residents.

The work of grassroots movements and local advocacy groups, such as NGOs can shed light on how the voices of local residents can be incorporated into the production of NbS. The NGOs Rame Rame Jakarta (Rame Rame Jakarta, 2021) in Indonesia and Kounkuey Design Initiative (KDI) (Konkuey Design Initiative, 2022) in Kenya, for instance, exemplify the efforts of emerging groups to give visibility to the local struggles of the urban poor. Using engagement practices such as emotional mapping and transect walks, the work of these NGOs emphasizes the relationships and knowledge sharing between stakeholders that can support a transformative design and implementation of NbS.

The work of Rame Rame Jakarta in Indonesia positions residents as the main actors in the process of understanding informal settlements and their needs (Rame Rame Jakarta, 2021). As such, the outcomes of their engagement practices identify the nuances of particular environments and the priorities of communities, revealing opportunities for institutional changes. The findings of their mapping processes draw on personal experiences of communities affected by floods, including children, and reveal essential insights into the local perceptions of the environment that can inform the production of more integrated and site-specific NbS.

Conclusions

In this Perspective article, we discussed examples of engagement practices that illustrate how consultative, co-designed and transformative approaches can be achieved. Drawing on lessons from the authors' own practices, we systematized our findings in the form of a framework, which adapts previous conceptual model of upgrading to the context of NbS (Sattherthwaite et al., 2020). This framework posits that transformative approaches should involve multiple stakeholders in order to foster positive changes in the institutional and socio-ecological systems. These approaches can be translated into connected and integrated visions of NbS if they are able to consider local priorities and environmental contexts.

Connecting with the needs of communities in their own terms should be a central aspect of transformative approaches toward NbS. Recent research on the topic indicates that this can be supported by the involvement of "gatekeepers" who promote that all voices are recognized and heard, and that local knowledge is integrated into project plans (Diep et al., 2022). The work of NGOs and grassroots movements can offer insights into how researchers and practitioners spearheading the use of NbS can overcome barriers that reinforce "power dynamics that restrict the participation of historically excluded actors" (p. 280; Woroniecki et al., 2020; Melanidis and Hagerman, 2022).

The examples highlight the importance of involving local actors who can champion deeply personal engagement practices to advance transformative approaches to NbS. The work of the NGO Rame Rame Jakarta in Indonesia, for example, is premised upon engagement practices that are not dictated by experts and technical requirements. Instead, by using emotional mapping, transect walks and other engagement practices with informal workers, their work offers opportunities for communities to play a key role in the process of mapping their environments and co-producing knowledge. These processes are key to accelerating institutional change and materializing new forms of multi-stakeholder governance of NbS (Frantzeskaki and Kabisch, 2016; Cousins, 2021).

The multi-stakeholder engagement practices in these projects were made possible through an iterative process that expanded beyond informative and consultive approaches and allowed NbS to be integrated with local needs and priorities that local stakeholders can relate to. Based on these examples, we argue that a transformative approach to NbS requires a different model of participation, one that is tightly connected to local ways of understanding the environment and its social relationships. Due to the multidimensional socio-ecological nature of NbS, it is important to highlight that manipulative and informative approaches are insufficient to support a just and site-specific implementation of these systems. Instead, a transformative practice should be premised on the understanding that community participation should inform the goals, values and expected outcomes of projects implementing NbS in informal settlements.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EW oversaw the research, co-designed the framework, and edited the manuscript. HR wrote the initial draft, co-designed the framework, edited the manuscript, and designed the supplementary material. PH co-designed the framework, reviewed, and edited the manuscript. LD reviewed and edited the manuscript. BN and KK provided papers and information for the research. All authors contributed to the article and approved the submitted version.

Funding

This research is supported by National Research Foundation, Prime Minister's Office, Singapore (award NRF-NRFF12-2020-0009).

Acknowledgments

We thank the reviewers for their precious insights and comments on this manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 19 October 2022
DOI 10.3389/frsc.2022.962168

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 06 June 2022
ACCEPTED 01 September 2022
PUBLISHED 19 October 2022

CITATION
Hardoy J, Motta JM, Kozak D, Almansi F, Reverter T and Costello M (2022) Exploring the links between the use of NbS, mindshifts and transformative urban coalitions to promote climate resilience within an ongoing reurbanization process. The case of Villa 20, Buenos Aires. *Front. Sustain. Cities* 4:962168. doi: 10.3389/frsc.2022.962168

Exploring the links between the use of NbS, mindshifts and transformative urban coalitions to promote climate resilience within an ongoing reurbanization process. The case of Villa 20, Buenos Aires

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In recent decades, informal settlement upgrading and housing deficit in Latin America has been addressed through a variety of urban programs, usually structured around physical-spatial and social actions with an emphasis on the provision of basic infrastructure and services, improved accessibility and connectivity and new housing, mostly done by conventional means. In general, they fail to incorporate new frameworks that provide solutions with strong environmental roots, such as Nature-based Solutions (NbS), Blue-Green Infrastructure (BGI) or Ecosystem-based Adaptation (EbA). This article explores the potentiality of NbS/BGI in contributing to solve structural problems in marginal urban areas, the mindshifts and actor coalitions needed to support this and how it may promote equity and justice. This is analyzed in a particular setting: Villa 20, an informal settlement in the City of Buenos Aires that is undergoing a participatory urban upgrading process with a strong participatory platform made up of multiple spaces and devices for consensual decision-making on re-urbanization aspects. In Villa 20, several interrelated projects and programs are focusing on sustainability. In particular, the Transformative Urban Coalitions (TUC) of the International Climate Initiative (IKI) is connecting decarbonization with urban inequalities and urban justice. The article reflects on some of the initial outcomes of the TUC program that builds upon the ongoing participatory upgrading process. To discuss the links between the use of NbS, mindshifts and transformative urban coalitions we look into the social setting, methods and tools that promote mindset shift. We explore initial mindset changes in government teams; community leaders; and

participants of an Urban Lab and the building up of a new transformative actor coalition. With this, we aim to better understand the possibilities and potential implications of implementing NbS in marginalized social contexts, contributing both to closing the knowledge gap and re-thinking future policies and programs.

KEYWORDS

decarbonization, transformative resilience, Nature-based Solutions, re urbanization, informal settlements, Buenos Aires

Introduction

Over the last decades, informal settlement upgrading and housing deficit in Latin America has been addressed through a variety of urban programs, often government led in partnership with other actors, structured around physical-spatial and social actions with an emphasis on the provision of basic infrastructure and services, improved accessibility and connectivity, and new housing (Brakarz et al., 2002; Rojas, 2009; Motta et al., 2018). This has been done mostly by conventional means and using gray infrastructure. More recently, these programs have started to address environmental concerns in relation to waste collection, safe sites and disaster risk reduction (Almansi et al., 2020). However, programs and interventions tend to fail to incorporate climate change considerations and new frameworks that provide solutions involving strong environmental roots, such as Nature-based Solutions (NbS), Blue-Green Infrastructure (BGI) or Ecosystem-based Adaptation (EbA). In fact, many of these upgrading programs developed well before there was any real concern around climate change impacts (Satterthwaite et al., 2020). There are still few studies on how informal settlement upgrading or re urbanization engages with climate change mitigation and adaptation (Collado and Wang, 2020). Seldom do programs in the region go a step beyond to provide for the needs these neighborhoods are experiencing today and will likely experience in the coming years in a context of climate change (Almansi et al., 2020). Not many programs aim for or result in providing integrated responses and the incorporation of climate resilience goals are usually complementary to the physical transformation of a neighborhood. Partially, this is because, as Ziervogel (2020) states, there is an inherent contradiction between "delivering urgent climate action while addressing the profound injustices that shape cities today" (p. 1) and "tensions between immediate needs vs. future needs" (p. 2). The lack of practical examples and inspiration could also be restraining needed changes. In other research[1] four 'must haves' have been summarized for upgrading initiatives to incorporate measures such as NbS/BGI that contribute to climate resilience building. The first two are pre-requisites in any upgrading process, the last two need to be incorporated more broadly.

- Support community organizations to ensure initiatives are rooted in real needs and priorities (e.g., design of a rain garden contributing to flood mitigation during heavy rains).
- Support genuine local partnerships to ensure coherence and continuity of neighborhood transformation processes (e.g., new actor coalitions are exchanging knowledge and perspectives that drive innovation).
- Accelerate the incorporation of climate considerations when funding and investing in upgrading initiatives, long lasting infrastructure, and land use transformation (e.g., climate change considerations are incorporated in tender documents).
- Ensure funding that supports incorporating climate resilience in upgrading processes, including support to develop local funding sources (e.g., build the case so that it is incorporated as current expenditures in projects).

Cities increasingly face climate change impacts associated with extreme heat events, floods, water stress and windstorms to name a few. This is coupled with air, water and soil pollution and loss of natural habitats. Climate change is disrupting lives and livelihoods, especially for those who are the most vulnerable. Literature covers well how climate related risks are amplified for those who live and work in informal settlements and deprived neighborhoods (Revi et al., 2014; Hallegatte et al., 2016; Bazaz et al., 2018; UN-Habitat, 2018; Dodman et al., 2019; Satterthwaite et al., 2020; Leal Filho et al., 2021; Castellanos and Lemos, 2022) and how cities need to systematically address environmental risks together with social change (Revi et al., 2014; Ziervogel, 2019).

1 See blog Hardoy (2021). Climate resilience building in informal settlement upgrading processes, in OECD Development matters https://oecd-development-matters.org/2021/03/05/climate-resilience-building-in-informal-settlement-upgrading-processes/?blogsub=confirming#blog_subscription-5.

Responding to these challenges requires profound system change that involves not only structural and behavioral changes but also the realignment of values and goals held by collective and individual actors (Bartlett et al., 2016), changing the fundamental attributes of a system (Pelling, 2011; Intergovernmental Panel on Climate Change (IPCC), 2014). It requires new distributions of rights and responsibilities between state and citizens (Fraser et al., 2016) and bold leadership. Thus, actor coalitions are needed with the potential to reimagine and experiment (Ziervogel, 2019, 2020) in real life contexts.

There is a very direct connection between adaptation and addressing what the IPCC terms "risk-reducing" infrastructure (piped water that is safe, sufficient and affordable; good-quality sanitation and electricity; all-weather access roads; storm and surface drainage and street lighting and risk-reducing services –including hospitals/health care, emergency services. This is usually provided through upgrading in informal settlements. If it is done well, it builds household and community resilience to climate change (Satterthwaite et al., 2018, 2020). There is a less direct connection, however key, between decarbonization and informal settlement upgrading. But the need for GHG emission reduction is pressing to avoid dangerous global warming and therefore involves, amongst other things, looking into the design of buildings and infrastructure so they have lower levels of embedded carbon (Bartlett et al., 2016), and avoid future carbon lock in. In addition, as we move toward a warmer climate, more adaption will be needed. And delaying actions today will very likely reduce options in the future; without mitigation there is no realistic desirable future. Thus, climate change adaptation and mitigation need to be woven in informal settlement upgrading processes. Incorporating the dimension of climate justice aims to place concerns of equity and fairness in the center of the discussion.

The integration of nature as a fundamental element in urban development is often considered a luxury vis-à-vis the multiple development constraints faced by cities in the global south, particularly in deprived neighborhoods. In practice, the incorporation of nature in informal settlement upgrading and re-urbanization programs usually comes at the end of long conflicting and tiring processes, full of expectations around improving basic habitat and housing conditions and secure tenure. "Green" is presented as an additional complement that can only be thought of once urgent issues have been resolved by conventional means (Kozak, 2021). In such a context, integrating nature is usually limited to designing a few public spaces and planting some trees and other vegetation. There is little consideration and discussion around the role of nature and the use of NbS, BGI and EbA as practices that contribute to solving structural deficits in low-income neighborhoods while supporting transformative climate resilience, equity and climate justice.

Literature on the topic covers well how, in theory and practice, NbS, BGI and EbA tools act multidimensionally with the potential to contribute to the resolution of a vast array of urban problems (e.g., floods, heat waves), while reducing GHG emissions, capturing air pollution and moderating the Heat Island effect, among many other benefits [FEBA (Friends of Ecosystem-based Adaptation), 2017; Browder et al., 2019; OCDE, 2020; Marsters et al., 2021; Ozment et al., 2021].

Despite progress made, there is an action and knowledge gap on how cities can further advance in the transformations needed to tackle climate change while ensuring response to the development needs of those most vulnerable and drive collective solutions (Garshagen et al., 2020). These include further exploration on transformative climate resilience, climate justice, and the use of NbS as a means to potentiate re-urbanization processes so that they can support transformation and climate justice. Cross-cutting these themes is the role of participation and mindset shifts. This article aims to start filling this gap by exploring the social context, methods and tools that promote mindshifts amongst local government teams, community leaders and actors participating within an urban lab set up to promote transformative change. This allows us to begin to examine the viability of new actor coalitions in promoting innovative ideas in already established participatory processes and explore to what extent the use of NbS can be advanced in marginalized urban social contexts, thus strengthening the search for equity and climate justice in reurbanization processes.

We discuss the links between the use of NbS, mindshifts and transformative urban coalitions in Villa 20, an informal settlement in the City of Buenos Aires that is undergoing a process of participatory redevelopment. Villa 20, or Barrio 20 (how today is usually referred to), is located in the area of Villa Lugano in Commune 8, in the southern part of the city of Buenos Aires (CABA), Argentina.[2] In 2016, its population approximately reached 30,000[3] inhabitants. It is the city's fourth most populous slum, representing almost 20 per cent of the city's total slum population.[4]

2 It is important to mention that in terms of Agenda, legal framework, institutional arrangements and funding possibilities, Argentina has advanced very much over the last years. highlighting the provincial aw 14.449 (Ley Acceso Justo al Hábitat) of 2012 and national aw 27.453 of 2018. Both are the result of the collaborative work and of social movements. Law 27.453 declares of public interest the regularization of informal neighborhoods and provides a residence certificate. The National registry of informal neighborhoods (Registro Nacional de Barrios Populares – RENABAP) generates data on these neighborhoods to aid the regularization process.

3 IVC (2016), *Informe Final Censo 2016 Villa 20*, Departamento de Estadísticas y Censos, gerencia Operativa de Intervención social y Hábitat, gerencia de Desarrollo Habitacional, Instituto de Vivienda de la Ciudad, Buenos aires, available at https://vivienda.buenosaires.gob.ar/censo-villa-20. At the beginning of the re – urbanization process a neighborhood census was coordinated by IVC.

4 Cosacov, N, M M Di Virgilio, A Gil, M L Gil y de Anso, T Guevara, M Imori, M L Menazzi, F Ostuni, C M Perea, M D Perelman, J M Ramos, M F rodríguez, M Paschkes Ronis and P Vitale (2011), *Barrios al Sur:*

The article reviews the implementation process of the first phase of the action-research program "Transformative Urban Coalitions: Catalyzing Urban Partnerships to Drive Systemic Transformation Toward Sustainability (TUC) of the International Climate Initiative (IKI)"[5] which aims to drive systemic transformations and connect decarbonization with urban inequalities and climate justice. In this first phase (2021–2023) the program in Buenos Aires is working to complement the ongoing reurbanization process, promoting the introduction of new ideas, tools and practices that aim to drive transformative change through the joint construction of an urban laboratory in Villa 20. When this article was submitted, we were half way through the first phase.

The article has six sections. Following the introduction, Section Concepts and methods covers concepts and the research methods used. Section Study area and project background presents briefly the study area and the goals of the TUC program. In Section Results, we present some initial results of the program by focusing on the tools and methods used to drive mindset shifts and support transformative coalitions. In Section Discussion the initial findings are discussed and Section Final reflections includes final reflections of the process.

Concepts and methods

Concepts

The TUC program is developed around the idea that decarbonization has to be socially just and that transformation has to be inclusive and driven by the needs and views of a diverse group of stakeholders. Villa 20 is appropriate as a case to develop the TUC action research project, allowing for a bottom-up approach to discuss ideas and procedures, co-design, generate consensus and implement jointly.

In the context of Villa 20, the key elements that facilitate mindshifts and build transformative urban coalitions (i.e., people working together to achieve radical change) are: (a) enabling individual and collective choices, (b) connecting with real social motives, and (c) supporting the circulation of ideas among participating actors and a broader set of stakeholders. Both mindset shifts and actor coalitions are central in supporting and promoting alternative frameworks and practices. The challenge is to explore –in the real world– how mindset shifts and new urban coalitions can actually guide urban transformation toward desirable urban futures that are just and inclusive.

The concept of Climate Justice (CJ) is rooted in the idea that while the responsibility for Climate Change (CC) lies by and large with wealthy people, its most severe impact disproportionately affects the poorest and most vulnerable. It is not only that those who have profited the least from the benefits brought by industrialization are now absorbing its negative externalities, it is also a question of basic human rights. Unless effective CJ policies are put forward to compensate for this injustice, a growing number of people –mostly in the Global South– will not be able to afford Climate Change Adaptation (CCA) and will be left to a recurring cycle of humanitarian crises.

As opposed to a purely environmental and naturalistic understanding of CC, the perspectives brought by CJ frame it as a political and ethical question.

CJ means that the costs of CC, both in terms of mitigation and adaptation, should be chiefly paid by the wealthy and most powerful. It also means that the efforts invested in climate-change action should also contribute to ameliorate social inequality. This is consistent with the call to generate synergies between mitigation, adaptation and sustainable development included in the sixth *Report on Climate Change 2022: Impacts, Adaptation and Vulnerability* of the II Working Group of the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change, I. P. C. C., 2022). That is, reducing the "trade-offs between adaptation and mitigation to advance sustainable development" (Intergovernmental Panel on Climate Change, I. P. C. C., 2022), (p. SPM-30). Or as Antwi-Agyei et al. (2017), (p. 11) put it: a "'triple win' of adaptation, mitigation and development." It is important, in all cases, to pay attention to how rights and responsibilities are distributed. Only recently is research exploring how climate justice addresses urban inequalities (Bulkeley and Edwards, 2014).

Achieving CJ is connected with the quality of participation and the spaces, methods and tools used to enable meaningful participation, problem solving and joint decision making.

Participation promotes that governance, policies and practices are discussed between those who are part and can be affected by the decisions made. Participation therefore, is a precondition in designing and implementing physical and social transformations within particular social and environmental settings (Motta, 2017).

There is a series of basic conditions to ensure high levels of participation in re-urbanization processes: (a) existence of political decision and resources; (b) existence of previous organizational processes that support and are willing to engage collectively in a process; (c) existence of a technical team trained to carry out substantial and locally designed participation

Villa Lugano, Villa Riachuelo, Mataderos, Parque Patricios y Villa Soldati a través del Tiempo, Working Paper 56, Instituto de Investigaciones Gino Germani-Universidad de Buenos aires (IIGG-UBA), Buenos Aires.

5 The International Climate Initiative (IKI) is an important part of the German government international climate finance commitment, led by Federal Ministry for Economic Affairs and Climate Action (BMWK). https://www.international-climate-initiative.com/en/about-iki/.

processes. Within this set of conditions, the participatory management process faces the challenge of balancing and articulating these three initial conditions with others that emerge as a result of the implementation of the participatory process, and includes decision-making both at macro and micro levels. The participatory process develops in time and space in the form of a dialectical spiral, with twists and turns, as consensus is reached and the process is adapted to give room to requirements that constantly arise in complex and uncertain contexts.

In the implementation of participatory processes, a main challenge is how conflict is managed while respecting consensus and promoting strategies that strengthen the levels of participation in the decision-making process. It is within this participatory framework that transformative change can happen, and can both tension and strengthen the relationship process-project (Motta and Almansi, 2017; Almansi et al., 2020; Motta et al., 2021), generating more radical changes.

Following a CJ perspective, it is worthwhile to explore the possibilities of implementing Blue-Green Infrastructure (BGI)[6] in low-income communities, such as Villa 20. As a general principle, BGI points to the recognition of the innate capacities of green space and water, and the ecosystems in which they are embedded, to produce environmental benefits and to enhance the quality of life (Kozak et al., 2020, 2021; Henderson et al., 2022). One of its most used definitions describes it as a:

> Strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services[7] [JNCC (Joint Nature Conservation Committee), 2019: 5].

The BGI toolkit includes components that have long existed in the vast majority of cities (e.g., parks, green corridors, rivers, streams, lagoons, wetlands, tree-lined boulevards and gardens), as well as innovations out of traditional urban elements (e.g., bio-retention reservoirs, floodable parks, green swales and other bio-infiltration devices). In other words, green spaces, watercourses and water bodies –of different sizes and shapes– have been part of the traditional landscape of cities in different cultures and geographies for ages. What is the advantage, then, of considering them now as part of a BGI? The advantages are manifold. Firstly, conceiving them –and consequently, planning, designing and managing them– in terms of infrastructure puts the focus on one of their main functions: that of constituting biological corridors and networks. These are networks that run through cities and metropolitan regions, connecting them with their hinterland, allowing biodiversity to flow. Like all kinds of infrastructure, BGI requires a fixed support, anchored to the territory, which facilitates the circulation and distribution of services. Just as the networks for water, electricity, natural gas, mobile phone, internet –and all of the urban infrastructure that support life in cities– require pipes, tanks, cables and antennas – which allow the circulation of flows (i.e., the services provided)– BGI is also made up of fixed parts, rooted in the earth that provide the necessary biological continuity for the provision of ecosystem services (such as the decrease of the Urban Heat Island effect and the regulation of temperature in general; improvements in the quality of air and water through the use of the phytoremediation capacity of urban vegetation; noise reduction; CO_2 capture; and greater control in the management of stormwater runoff; among many others).

Secondly, thinking of green spaces, watercourses and water bodies in cities as nodes, links and connectors of a network – and not as isolated episodes– not only enhances the capacity to produce ecosystem services and the management of their distribution, but also makes it possible to create circuits and itineraries with environmental quality, which enable new ways of circulating in cities. For this reason, BGI synergizes with sustainable mobility networks and particularly with those of non-motorized modes.

Finally, planning cities in these terms, quantifying the benefits and the socio-environmental contribution of ecosystem services, also makes it easier to discuss BGI on an equal footing with the other urban infrastructure, including –and especially– the allocation of resources. This means shifting landscape planning and design from the place of the ornamental, sumptuous and accessory, to that of the productive and essential; understand their budgets as an investment (in the same sense as that of the rest of the urban infrastructure) and not as an expense (as the maintenance of green spaces is traditionally conceived in municipal management).

Planning BGI means making room for nature in the city.[8] This motto, necessary in all city neighborhoods, is particularly urgent in low-income neighborhoods, where the highest levels of overcrowding are found and public spaces act as essential expansions of the houses and flats. It is also in these neighborhoods where there is usually less quality green space per inhabitant, and where the phytoremediation capacity of vegetation is also most needed, along with the provision of ecosystem services to cope with heat waves and flood risk.

The current COVID-19 crisis has highlighted the need for quality green spaces close to where people live –ideally, in <15-min walk. A robust BGI network reduces the risk of flooding and improves the quality of water in storm water systems and their recipient water bodies, while promoting sustainable mobility and contributing to improving environmental quality.

6 BGI is usually understood as a form of NbS.

7 Ecosystem services are the multitude of benefits that nature provides to society. Biodiversity is the diversity that exists among living organisms, which is essential for the function of ecosystems and for them to provide their services (see FAO, 2021).

8 We refer here to the construction of places that favor the generation of natural ecosystems located in the city, deliberately avoiding the theoretical debate on the nature-artifice dichotomy.

Cities with better BGI networks, *ceteris paribus*, have better resources to cope with the current pandemic. Firstly, due to the high correlation between environmental quality and lethality of COVID-19, particularly in terms of air pollution.[9] But also in terms of availability of contact with natural environments to look after the mental health of the population;[10] even more so if the BGI is intertwined with mobility networks for pedestrians and cyclists.

The installed idea that the urgent needs of low-income neighborhoods, such as Villa 20, do not allow to pay attention to the environmental dimension in their planning and management hinders the ability to notice the multidimensional potential of BGI and its direct and indirect benefits in socio-economic and socio-environmental terms. The challenge is to think of BGI in low-income neighborhoods not as a complement that can be incorporated once all the previous urgencies have been resolved, but as one of the means available to address those urgencies; a path to the provision of services and the construction of urbanity with quality of life.

The incorporation of ideas in relation to SbN, sustainability and transformative change involves mindshifts and requires reflection on how ideas are transferred, co-created and circulated, together with a question mark regarding those whose needs and aspirations are being addressed (Romero Lankao et al., 2018; Chu and Cannon, 2021; Leal Filho et al., 2021). Díaz-Márquez (2019) brings attention to how in the process of circulating ideas, initial chore ideas are modified and new, unexpected, outperforming ideas emerge. The accent is placed in the internal capacity of individual and collective actors in changing ideas and therefore their reality (Liernur, 1986; Jajamovich, 2013). In the case of the re-urbanization process of Villa 20, social relations are built and strengthened around the circulation of ideas. These collectively constructed outperforming or out-of-the-box ideas guide the implementation of the re-urbanization process. In Villa 20, this molded the relationship between actors, the dialogue between demands and outcomes, and the overall management of the process. There was no space for copycat, importing or imposing ideas. Each one of the elements and instances of the re-urbanization process was the product of a discussion that resulted in an alternative idea than the one originally envisaged. This platform holds the TUC program, and sets the bar high. Any new idea and its implementation will be discussed, de-constructed and implemented only if it contributes to solving neighborhood needs. Discussion of ideas in the Buenos Aires UL of the TUC program are always filtered by their pertinence, social acceptance and their contribution to solve identified needs. Special attention is paid to the horizontal circulation of ideas and knowledge between actors and the integration of ideas and concepts missing until now.

Research methods

Research for this paper was conducted by a group of professionals and academics involved in one of the TUC program pilot cities (Buenos Aires), and responsible for the implementation of catalytic initiatives in Barrio 20 as well as the operation of an Urban Lab where new or alternative ideas can be discussed amongst a broad group of actors to create innovative solutions in a real-life setting. The TUC program is based on a process of action-research where different instruments, strategies and means are applied for the collection of information: interviews, direct observations, video recordings, document analysis, etc. Mainly, the techniques focus on direct or participatory observation, semi-structured interviews and audio and video recordings. These techniques allow triangulation of different sources and the use of flexible strategies given the diversity of ongoing situations, increasing interpretative certainty.

Data for the paper was collected during 2021 and part of 2022. Its collection, analysis and systematization are the result of a process of social construction of knowledge brought about by the interaction of participating actors and gathered during dialogues with key actors, small group meetings, field trips, and urban labs. Instruments are socially constructed by the participating actors of the Urban Lab: social leaders of Villa 20, city officials of the Housing Institute of the City who coordinate the re urbanization process in Barrio 20, city officials from the Environmental Protection Agency who develop the city climate agenda, and city officials from the Urban Anthropology Secretariat that produce data for climate analysis, amongst others. The collective process allows us to reflect on ongoing practice, learn from it, conceptualize, and generate feedback that can further improve work. The social construction of knowledge operates as an integrating axis between practice and the transformation sought from the implementation of the TUC program.

These socially constructed and locally generated data is complemented with information from the ongoing re urbanization process and specific literature that contributes to advance our understanding on the possibilities and potential implications of implementing NbS in marginalized social contexts.

Though the IKI TUC project on which we develop our research is at an early stage it has, nevertheless, generated some

9 See, for example, Bhaskar et al. (2020). Beyond the current pandemic, the magnitude of the harmful effects of atmospheric pollution on health –mainly produced by the emission of internal combustion engines– was already well known, in terms of incidence in the increase in respiratory diseases, disorders in cognitive development and premature deaths.

10 Access to green spaces reduces the risk of developing a wide range of disorders in children during adolescence and in adults. It is an important intervention at an early age to reduce the risk of depression, anxiety and drug abuse. See, for example, Engemann et al. (2019).

evidence that shows an initial transformation in mindsets and actor coalitions. We organize these evidence in two analytical dimensions: (a) mindshifts and new coalitions expressed in changes of discourse of participating actors and integration of new actors and (b) design of interventions by the integration of ideas that were not on the discussed before.

Study area and project background

Study setting

The re-urbanization process in Villa 20 (see Figure 1) began in 2016 and it is anchored in a strong participatory platform made up of multiple spaces and devices for consensual decision-making on re-urbanization aspects (Motta and Almansi, 2017; Motta et al., 2018; Almansi et al., 2020). Until the participatory process of socio-urban integration started in 2016, Villa 20 shared the typical problems of low-income neighborhoods: lack of adequate provision of basic services and infrastructure (water, sanitation, electricity, all-weather roads, education and health services, communal and green open spaces), as well as poor housing conditions, overcrowding, poor ventilation and lack of natural light.

Due to its dimension and characteristics, the re-urbanization process-project (Motta and Almansi, 2017) of Villa 20 is a complex intervention developed in stages, coordinated by the Instituto de la Vivienda de la Ciudad (Institute of Housing of the City of Buenos Aires – IVC[11]) and designed by the Participatory Management table (*Mesa de Gestión Participativa - MGP*) established by Law 5705/2016 of the City of Buenos Aires, which provided the legal support to the participatory process. Each stage of the process-project has different participatory devices which allow reaching decisions by consensus over varied aspects and themes. From the beginning, the different steps and participatory devices contributed to the design and implementations of the urban, housing and socio-economical dimensions of the re-urbanization process. In 2018, an Environmental-care table (*Mesa de Cuidado Ambiental*) was created to discuss and solve environmental problems, such as urban solid waste collection, floods, pests (especially rats), among others.

> *"Villa 20 has the best re urbanization law amongst all villas of the city of Buenos Aires. The secret to this is to have different political factions or fronts working together with neighbors and reaching consensus. We have discussions but the idea is to add, to push forward. In six years, much has been achieved but much remains to be done. My son has learned from all this, he will carry on in the future as the re urbanization process needs at least three more decades" (Community leader, march 2022).*

In this particular setting, between 2018 and 2019 authors participated in the inception phase of the TUC program, which finally started in 2021 and is currently half-way of phase 1[12]. Villa 20 represented an ideal setting to test and develop the TUC program due to its strong and consolidated participatory process cross-cutting an ongoing reurbanization process. This included strong social relations and shared capacities between actors, a solid community organization and experience in practical physical transformations, therefore permeable to a virtuous process of circulation of old and new ideas. In addition, members of the Buenos Aires TUC team had been involved in the initial years of the reurbanization planning process maintaining very good relations and trust with community leaders, neighbors and the city government teams coordinating the re urbanization process.

Today in Villa 20, several interrelated projects and programs are focusing on sustainability. In addition to the TUC program there are also the following initiatives: (1). the Estrategia de Vivienda y Hábitat Sustentable (EVHS - Strategy of Sustainable Housing and Habitat), which is a government platform designed to improve urban conditions while reducing environmental impacts promoting adequate and affordable housing, norms on bioclimatic construction, energy efficiency and renewable sources, awareness raising, innovation, and development of indicators; (2). The Environmental Sustainability Project funded by Development Bank of Latin America (CAF) which is a component of the Socio-integration program of Villa 20, Rodrigo Bueno and Playón Chacarita. It aims to strengthen IVC responses in relation to environmental sustainability[13]; and (3). A cooperation with Agence Française de Dévelopment (AFD) to support the city in developing urban policies and sustainable mobility[14]. An important difference between these programs and TUC is the approach used, while these tend to be top-down in their design, TUC proposes active co-design and collaboration.

11 The Institute of Housing is an entity of the government of the autonomous City of Buenos Aires with administrative and financial autonomy, whose role is to implement housing policies in the city.

12 The Project started in 2021. It is planned in two phases: phase 1: 2021 – 2023, and phase 2: 2024 – 2026.

13 It works across three axes: a. capacity building of community members and IVC staff on themes that go from sustainable design and bioclimatic architecture to circular economy, b. Solid waste management, and c. neighborhood project fund to support community actions on energy efficiency, use of renewable energy sources, urban green, vegetable gardens amongst others.

14 In the case of Villa 20, a participatory diagnosis identified the need for tactical urbanism, coordinating a cultural, social and sports agenda, and improving green spaces.

Project background

The TUC program aims to shift the sustainability trajectory of cities toward zero carbon emissions by 2050 by altering the deeper social, technological, and political structures and systems that are currently reinforcing high-carbon, resource-intensive urbanization. With this goal in mind, the program facilitates the establishment of transformative urban coalitions to develop new strategies for addressing local challenges in urban development and inequality while at the same time reducing carbon emissions. It is sustained on the idea that to be sustainable, rapid decarbonization has to be socially just and should create tangible social value. Therefore, transformations must be inclusive and driven by the needs and views of diverse groups of stakeholders, including citizens, policy makers, private sector and community-led organizations, among others. In order to change structures and values, the program seeks to shift the mind-sets of citizens and urban decision makers and build new actor coalitions.

It is led by a consortium of organizations (The United Nations University Institute for Environment and Human Security, UNU – EHS; the World Resources Institute, WRI; the International Institute for Environment and Development, IIED; and German Institute of Development and Sustainability, IDOS), and implemented locally by WRI Brazil, WRI Mexico and IIED – América Latina in five Latin American cities[15] with their respective catalyst projects. It has various work packages (transformative research, capacity sharing, community of transformation, comms and film) structured around the implementation of projects in each of the pilot cities. TUC employs the approach of Urban Labs to support the implementation of catalyst projects and promote the creation of transformative coalitions. Within these urban labs, local actors explore, co-create and innovate in real-life contexts to shift development pathways.

Applying an urban-lab framework, TUC in Buenos Aires aims to generate mindset shifts across multiple actors and transformative urban coalitions to support decarbonization, equity and climate justice by means of integrating alternative practices such as the use of BGI approaches to potentiate a re-urbanization process, and in this way make them an integral component of future re-urbanization processes. In this context, decarbonization is not just an end in itself, but a means of solving structural problems and advancing climate justice in the process.

Results

With the idea of understanding how to promote processes that facilitate mind shifts toward climate adaptation and mitigation actions in marginalized communities, we reflect on the initial outcomes of the TUC program in Villa 20 currently underway. A growing body of literature points to the need for caution in framing resilience and climate adaptation related interventions as benefiting everyone (Chu et al., 2016; Meerow and Newell, 2016; Shi et al., 2016; Chu and Cannon, 2021; Johnson et al., 2021; Leal Filho et al., 2021). Therefore, right from the start, special consideration has been placed on: (1). co-designing the intervention strategy, discussing tools and methodologies and sharing information and knowledge between all participating actors; (2). The design of NbS as an integral component of adaptation and mitigation actions with the potential of triggering other social benefits.

As explained, we explore changes in mindsets of stakeholders involved in the TUC program and how, in the context of the Buenos Aires urban lab, ideas for Villa 20 are co-created driving transformative change. Essential to our research is to gain understanding on how to support processes that trigger mind shifts toward decarbonization and transformation, and the central role played by "participation." We will briefly present the strategy and tools used during this first year of implementation and highlight some initial mind-shifts we observe between those involved in Buenos Aires.

TUC implementation

The TUC program started in 2021 in the middle of the pandemic. In Buenos Aires, as in other places, it was impossible to generate face-to-face exchanges. During most of 2021 the team in Buenos Aires focused on generating bilateral meetings with different actors from government, the community, the academy and NGOs. These bilateral meetings initially presented the program, how it linked into the re-urbanization process of Villa 20 and its potential of influencing future urban policies regarding informal settlements. Exchanges also allowed for the presentation and discussion of the concepts and tools used in TUC such as decarbonization, transformative change, NbS and BGI, the idea to work within urban labs and how it all connected and contributed to the ongoing re-urbanization process. An initial stakeholder map and the local context knowledge of the team contributed to identify who our main partners were for the initial stages of the program.

The main actors are the following:

- IVC with its different dependencies as they coordinated the re-urbanization process in Villa 20 and other informal settlements within the city. Also, they are housed within the Ministry of Human Development and Habitat responsible for coordinating all social integration programs. Within IVC, we coordinate work with International Relations

15 The five cities are: Recife and Teresina in Brazil; Neucalpan and León in Mexico, and Buenos Aires in Argentina.

FIGURE 1
View of Villa 20. Source: IVC 2021.

in charge of overseeing all international programs, the "technical team" responsible for designing physical intervention and overseeing construction work, "the social team" that ensures the coordination of social policies and the "coordination team" responsible of tying everything together and make it work for the neighbors of Villa 20. With the teams within IVC we had a number of meetings and in September of 2021 signed a collaboration agreement for the implementation of the TUC program in Villa 20. With the "coordination team." We also engaged with the coordinators of the Strategy of Sustainable Housing and Habitat (EVHS) and Environmental Sustainability Project that had also begun their work so as to align strategies and search for complementarities.

- Community leaders: Villa 20 has a very strong social organization operating under the umbrella of different political fronts. In the past, they fought for needed improvements and recognition, up until 2016 when the Integral Upgrading Process for Villa 20 was approved unanimously by the city legislature. Thereafter, community leaders have worked together to ensure the materialization of the integral upgrading process, the building of new houses and the titling process. We had several bilateral meetings with community leaders, we discussed and reframed concepts, included their concerns and began to co-design a specific engagement strategy with the community.

> *"IKI [The TUC program][16] brought an environmental dimension, we have severe environmental problems. When it rains water drains and sewage gets clogged, everything is cement and gray, we don't have green spaces" (Interview with community leader, March 2022).*
>
> *Neighborhood priorities, everything connects to the environment, for example rain or extreme temperatures reheats [electrical] cables, generates an explosion and fire. Now we talk more about it and begin to connect (Interview with community leader, March 2022).*
>
> *What do I expect from IKI [the TUC program]? I wish for tools, gain knowledge, and understand the problems ahead that we need to deal with. During the [re urbanization] process we kept talking about the environment but we really do not understand what it is. We talk about waste, recycling. If you ask me, I will tell you we need trees but I have no idea why or which trees are best. So, we want to have tools so we can claim for our rights and generate awareness amongst neighbors (Interview with community leader, March 2022).*

- Other city government offices: In particular, we began to articulate with the City Environmental Agency

16 The IKI TUC program is commonly referred to as IKI (International Climate Initiative or Internationale Klimaschutzinitiative in German).

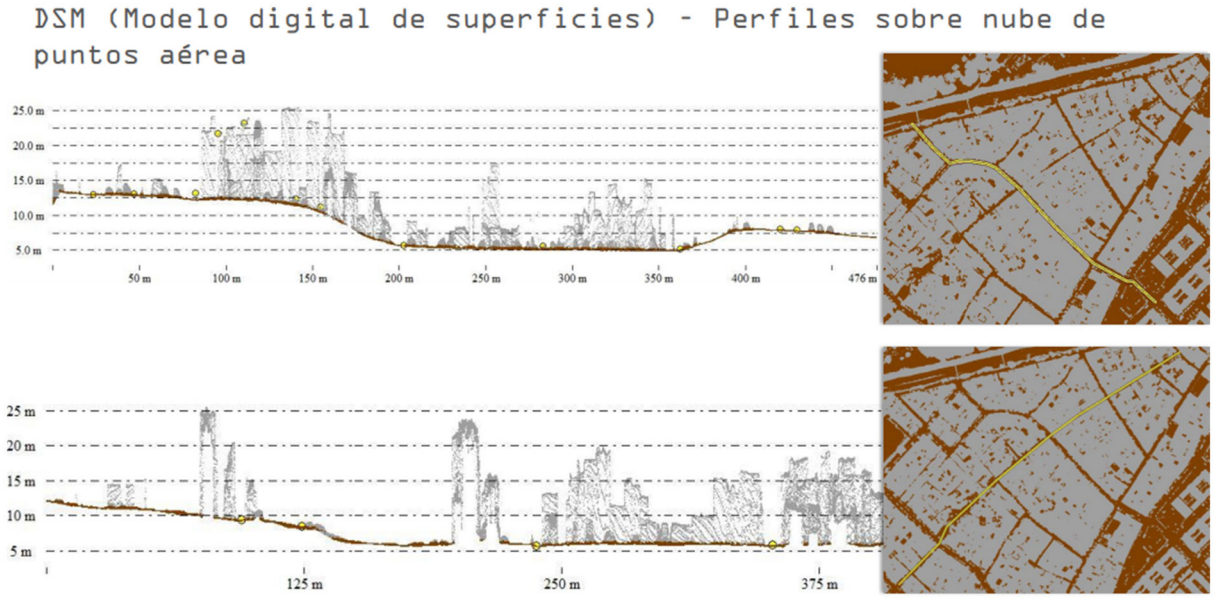

FIGURE 2
Example of Geospatial information generated for Villa 20. Source: Office of Data Generation (Gerencia Operativa de Datos Territoriales), DG Urban Anthropology, SECDU, 2022.

(*Agencia de Protección Ambiental* – AprA) that is responsible of the City Climate Plan (PAC) and through them we were approached by the Office of Data Generation (*Gerencia Operativa de Datos Territoriales*) of the Office of Urban Anthropology. Until recently, these government areas had very little work in informal settlements.

> *"..members of APrA were invited to a workshop in Buenos Aires during the inception phase of TUC [June 2019].. I was particularly taken by the program and saw an opportunity to work more closely with staff involved in the coordination of the re urbanization process in Villa 20 and start incorporating indicators related to informal settlements in the PAC" (Meeting with Climate Manager of APrA, March 2022).*

Later that year APrA conducted a pilot study to monitor temperature within Villa 20. Once we started with the Urban Lab the Office of Data Generation offered to prepare geospatial information for Villa 20 regarding sun incidence and solar radiation, digital elevation, soil absorption capacity, and temperatures as shown in Figure 2.

As briefly explained in Section Study area and project background, the participatory work in Villa 20 that supports the re urbanization process-project is organized around a series of participatory devices that operate at different scales. The main device is the participatory management table (*MGP*) where representatives from the community supported by a group of academics, NGOs, the ombudsman and professionals from the city government build consensus and oversee the general re urbanization strategy. The Environmental care table (*Mesa de cuidado Ambiental*) took responsibility overseeing mostly day-to-day environmental problems associated with garbage collection, rodents and their relation to health problems. After the COVID 19 pandemic this table was renamed Environmental table (*Mesa Ambiental*) and in late 2021, when face-to-face group meetings were approved, it was natural that all sustainability projects and programs involving in one way or another Villa 20 would be discussed within this table. The TUC program was presented and soon it was settled that on a monthly basis these meetings would focus on co-designing the catalyst project. These meetings turned into the Buenos Aires Urban Lab, where we discuss ideas, iterate, innovate and plan to implement in a real-life context. In these meetings, we have the participation of all members of the environmental table (community leaders, city ombudsmen, IVC) plus representatives of APrA, Urban Anthropology, the other sustainability projects, and the TUC team. We invite specialists, academics, other community or government referents, as needed. Therefore, Urban Lab meetings become an opportunity to bring in new actors, ideas, resources, strategies, and greater incidence capacity, and in the process form a new actor coalition.

Analytical dimensions of transformative change

Mindshifts and new actor coalitions

To drive transformation the local team of the TUC program designed an incremental engagement strategy. A sequence of

FIGURE 3
Urban Lab Buenos Aires – 1st meeting, March, 2022. Source: TUC program.

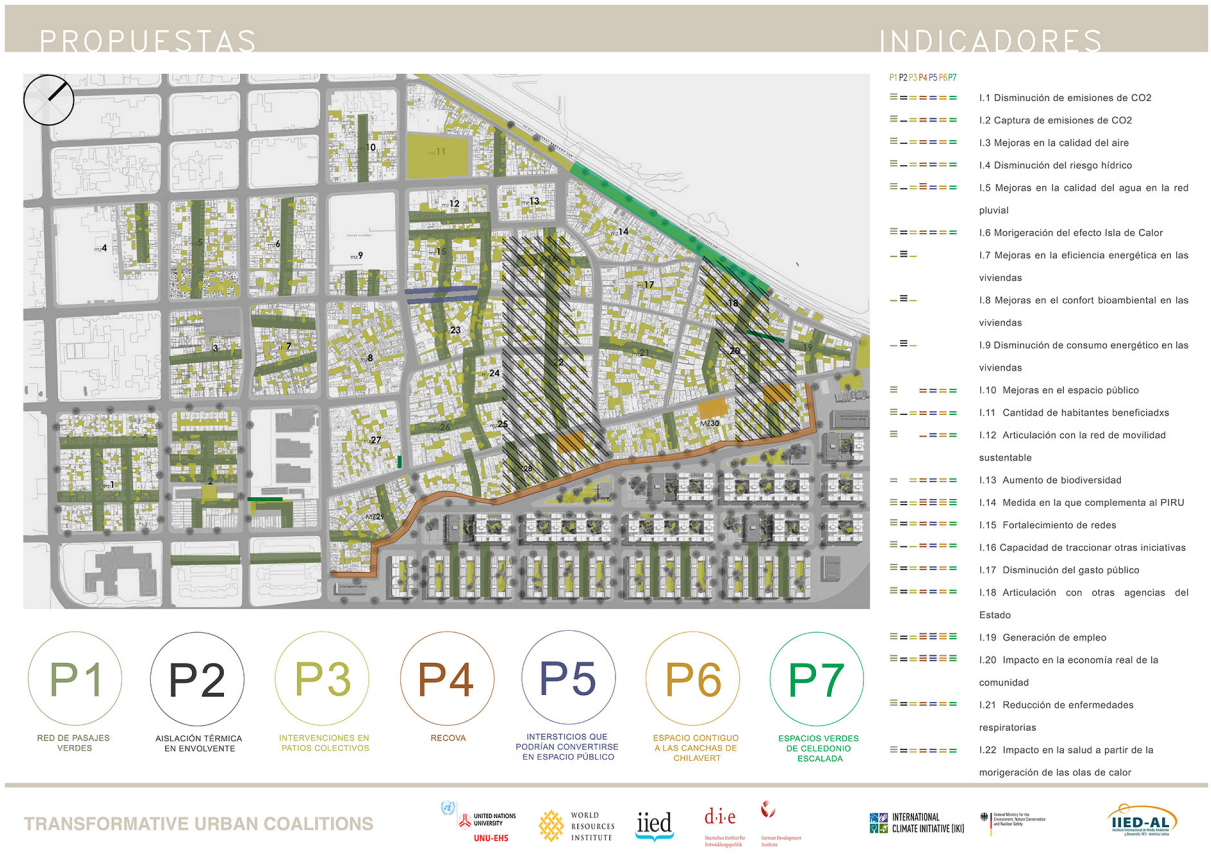

FIGURE 4
Possible pilot projects with indicators. Source TUC Program.

FIGURE 5
Visit to Paseo Ambiental del Sur APRA, April 2022. Source TUC Program.

FIGURE 6
Urban Lab Buenos Aires, 3rd meeting, May 2022. Source TUC Program.

six urban lab meetings was designed with its corresponding set of tools and methodologies to reach various results during each meeting. In between these urban labs, individual and small group meetings were held with participating actors to design and validate each one of the following steps, including the next urban lab workshop.

Urban-lab workshops cover presentation of participants, their role and interests, presentation of the TUC program, recap of the re-urbanization process, explanation of new concepts and hand on engagement with participatory design and in the near future with implementation and monitoring.

In order to achieve the integration of actors and enhance the work of the coalition, it was necessary to identify what contributions were brought to the urban Lab by each one. In this sense, the first urban Lab workshop was aimed at having each of the groups of actors present their specific knowledge and made available to the new coalition to guide decisions (see Figure 3). The systematization of the written and audio-visual records of the urban Lab shows how collective knowledge is gradually built: the group of social leaders described the re urbanization process, the IVC presented an update of the re urbanization work plan, APrA presented the multiple activities they carry out in relation to climate change and especially described the study of heat islands implemented in Villa 20, and urban anthropology described the digital geospatial analysis tools it uses to generate maps of solar radiation and temperature, models of digital elevation, urban vegetation, etc. and how this could be used in Villa 20, and the TUC team presented initial ideas of the use of NbS and BGI with concrete examples that could be used.

In a following urban lab workshop we continued to share information on experiences where NbS/BGI was used in different contexts as a way to inspire innovation and worked on a general evaluation of different sectors of the neighborhood to be intervened. A matrix with possible areas of intervention, typologies of interventions and a set of indicators to understand what these measures were contributing to was used as a tool to evaluate the relevance of the intervention in the different sectors.

The matrix proposed a number of possible pilot projects (P1 to P7) and identified a series of indicators related to the aims of the TUC project (I1 to I22). The potential projects included interventions aimed at architectural scale (e.g., addition of thermal insulation in the building envelope of existing houses), as well as urban-scale proposals (e.g., a network of green streets). The indicators linked to the pilot projects can be divided between: a. those that aim to measure environmental benefits, including decarbonization (e.g., reduction in CO_2; carbon sequestration; air/water quality improvement; flood-risk reduction), and b. those that aim to assess general co-benefits, including the strengthening of the current re-urbanization process (e.g., public-space improvement; job creation; strengthening of community networks). The matrix was summarized and illustrated on a map with the geo-identification of the proposed pilot projects (Figure 4 and Table 1).

In addition, a guided visit coordinated by APrA to a nature reserve[17] near Villa 20, including composting stations, nurseries, orchards, wetlands, wind turbines and solar panels, was generated as a learning and exchange opportunity, as triggers for intervention ideas (Figure 5).

The progressive development of a new coalition of actors is central in supporting mind-shifts. The incorporation of new actors to the ongoing participatory process is gradual and by means of the Urban Lab, as they incorporate new frameworks, participating actors also need to integrate knowledge developed during the re urbanization process (Figure 6). We soon began to observe and register mind-shifts, actors incorporating new concepts and ideas, considering their relevance, social acceptance and if they are contributing to solve identified needs, and coalition building. For example:

> *"Maybe I didn't realize it, but when they showed it to me, we went to the finalized alley [Passage 19] and it is all cement. There is a lack of green, I don't know why, but it is missing. We wanted so much to finish the passage and we didn't think of something more sustainable," (Community leader, March 2022).*

These initial three urban lab meetings, together with encounters with community leaders, technical and coordination teams from IVC and territorial visits prepared the setting for a fourth urban lab meeting focused on design interventions.

In the following urban lab, during the workshop, participants were divided in three groups to agree on a set of goals TUC interventions should respond to and discuss and agree, in broad terms, areas and types of intervention. Participants agreed on a shared goal: through the collaborative work of actors to improve bioclimatic comfort of houses to reduce respiratory problems. And included several specific goals: complement the re-urbanization process and other public-private interventions in the neighborhood, reduce the heat island effect and flood risk, improve stormwater quality, use of communal spaces, enhance biodiversity and awareness raising on climate change and environmental risks and the need to sustain actions in the long term.

A workshop methodology was applied based on the use of a toolbox (see Figure 7) containing different cards associated to a type of intervention (e.g., tree and shrub planting, green walls, pergolas, rain gardens, permeable soil, etc.), possible areas of intervention (street, alley, communal courtyard, public space), and as well as the necessary activities to sustain it (related to ownership, capacity building, awareness raising, maintenance, among others).

17 Visit to 'Paseo Ambiental del Sur' on April 2022.

FIGURE 7
Tool kit to aid design of interventions during participatory planning workshop: Source: TUC Program.

Finally different intervention areas were prioritized and agreement was reached on three intervention levels (retrofitting finished work, new minor interventions in alleys and courtyards, and complex interventions in new streets. In addition, modifications to tender documents, connections to other ongoing projects, and an overall "green" master plan for the neighborhood began to be discussed.

Design of interventions as drivers of transformative change

The fourth urban lab was carried out before the closing of this paper. Its goal was to initiate the participatory design of each intervention by sector, with the participation of the community (neighbors from each sector) (see Figure 8). Each sector group was provided with satellite images, maps of particular areas, transparencies with elements such as trees, shrubs, green walls, and small urban wildlife, tools for cutting and pasting, and catalogs of native vegetation and NbS and BGI tools to consult. After a recap on past urban labs and an introductory presentation by a landscape specialist, each group discussed problems associated with climate impacts and began a hands-on process to design a possible intervention. The following figures illustrate the process.

The problems to be mitigated with TUC interventions are, in general: heat in summer, reduced sunlight in winter, absence of vegetation and absorbent soil, reduced space for incorporation of street furniture or BGI interventions, car parking in pedestrian areas. The interventions proposed were: vegetation on vertical support, flower beds, complementary structures between opposite front walls as support for vegetation - shade planes, incorporation of absorbent soil sectors, murals with games, tensors between facades (support for green - shade planes), trellis trees, vehicle control devices, signage and labeling: to interpret the heritage of the elements present and that are being added in the area.

The potential of physical transformations within the neighborhood through the co-design of different interventions applying NbS tools that complements the construction work of the re-urbanization can be seen in Figure 9. These physical transformations contribute to anchor ideas in a real-life setting, implementing options that can be measured qualitatively and quantitatively, generate appropriation, and convince others regarding the multiple benefits of NbS. NbS/BGI measures are discussed and a new dialogue established with technical government teams to discuss possibilities, this is validated by the different actors involved in the urban laboratory, and acts as a catalytic of mindshifts.

Next steps include meetings and UL workshops to discuss initial technical and financial feasibility, preparation of executive project drafts to discuss at workshops focused on each of the areas of intervention, preparation of budget and implementation plan.

Discussion

As mentioned, we are at an early stage of the IKI TUC project, however we are registering evidence of the transformation process initiated. We find evidence of mindshifts

A

B

C

FIGURE 8
(A–C) Working during Urban Lab meeting, June 2022. Source: TUC team.

FIGURE 9
(A–D) Working on ideas of pilot projects - Before and after - during Urban Lab meeting, June 2022. Source: Mariana Giusti for TUC program.

and new actor coalitions along three different dimensions as mentioned in Section Concepts and methods.

From dialogues with community leaders, it is clear that everyone is learning by doing and that the TUC program offers an opportunity to debate over themes that were almost absent from the re-urbanization process – and even city planning at large. For example, a community project funded under the Environmental Sustainability project of CAF opted to work on *Pasaje 19* in order to generate awareness by means of and artistic intervention and align that intervention with the use of BGI designed within the TUC project. There is a recognition that environmental aspects were usually something to be discussed once other pressing issues were covered. However, now it is easier to see connections and how addressing these environmental concerns within the design process maximizes outcomes, for example the use of impervious soil may be contributing to increased water runoff and the lack of green increases heat island effect. From records of meetings of the *Mesa de Cuidado Ambiental* initially and now *Mesa Ambiental* it is possible to observe how the focus has shifted from addressing environmental emergencies such as waste collection to more strategic and long-term environmental concerns such as heat island effect and heat waves or the need to incorporate pervious ground.

In many aspects, TUC program provides a support mechanism to enable a learning process and empower citizens to meaningfully engage in a collective planning process. If they know what to ask for, community leaders will act to get it and will work with their neighbors to raise awareness and generate appropriation and commitment.

> *"The educational part is fundamental, to sit down and explain ourselves from scratch. We learned how to read architectural plans from scratch, and we ended up modifying them. We learned what sustainability is, what renewable energies are, how they work in other countries, their benefits, that maybe they work in other countries and not here. . . . We need knowledge, not only at the environmental table, I had proposed to go to schools, those kids have already grown up in another context" (Community leader, march 2022).*

A much-awaited intervention of the re-urbanization process was the opening of an alley (Pasaje 19) and it was nicely done. However, after months of talking about climate change, NbS and BGI, urban-lab participants realized that these pedestrian walkway had all types of green missing as mentioned earlier in the article. A recognition it had been a missed opportunity to design something better, more forward looking into the climate problems they were already experiencing. The same occurs in terms of the design of new housing and institutional buildings within the neighborhood, or the use of renewable energies; what could have been done better? What can we do from now on? The visit generated by APrA to Paseo Ambiental del Sur allowed participants to incorporate in their intervention's new insights. Awareness regarding the missing green goes beyond Pasaje 19.

> *"..we never talked about it at the MGP. For example, when we discussed about the new buildings being constructed, we thought they had to have a patio and green areas. But when they told us about including green terraces, we said no because of the cost for the neighbor to maintain them. We could have said yes and discuss that city government be in charge of maintaining it until the building consortium could. Now we are complaining because we did not put green terraces, what fools" (Community leader, march 2022).*

Interest generated on the TUC project is also a noteworthy indicator. Not only has the *Mesa Ambiental* allocated time to work on the TUC project, commitment is also constantly high. Meetings have regularly 30 participants. In between workshops there is constant generation of bilateral meetings or activities in relation to the themes of the project.

The urban lab in terms of the different actors involved and the TUC program, are soon becoming a kind of trusted "advisors" on these themes. Each participating actor comes with particular expertise, resources, capacity to generate data, and bring other actors onboard. Its horizontal participatory dynamic allows a collective design of the process.

> *"When we started discussing new housing, architects from the university showed us that we could do other things such as patios to improve ventilation, green spaces, etc. We could discuss that because we had learned about it and worked with the architects who were advising us" (Community leader, march 2022).*
>
> *"I would like IKI TUC to contribute to building better public policies. In Barrio 20 things have been done differently. I am a teacher; I would like future generations to think about the environment in all areas" (Community leader, march 2022).*

For government teams, TUC is also providing a valuable opportunity, especially in terms of actor engagement and facilitating discussions that were not really on the table due to other priorities and agendas.

> *"Our work is evaluated in terms of achieving specific results and using NbS/BGI is not between them . . . TUC provides an opportunity to discuss in detail themes that are left out due to other priorities, lack of specific tools and time" (City official, may 2022).*

Both APrA and Urban Anthropology are collaborating actively in the urban lab. For example, along with APrA we are designing a strategy to install temperature and humidity stations to monitor changes, with the aim of using it as an awareness

TABLE 1 Criteria used to aid prioritization of interventions.

Criteria	Climatic corridors Plan	Influence construction documents of re-urbanization plan	Community awareness	NbS within communal patios	NbS in Alley of block 19	NbS in Alley of block 20	NbS in Barros Pazos street
Climate benefits							
Reduce CO_2 emissions							
Capture CO_2 emissions							
Increase biodiversity							
Mitigate heat island effect							
Urban environmental benefits							
Improve air quality							
Reduce flood risk							
Improve bioclimatic comfort of houses							
Improve water quality that goes to drainage system							
Improve use if public space							
Articulate with the sustainable mobility network							
Complements the re urbanization process							
Capacity to trigger other initiatives							
Reduces public expenditures							
Articulates with multiple government agendas							
Social benefits							
Strengthens networks							
Has a real positive economic impact within the community							
Reduces respiratory diseases							
Positive health impacts related to mitigation of heat waves							

Source TUC Program.

10.3389/frsc.2022.962168

raising tool, generating data for the City Climate Action Plan, monitoring TUC interventions and as an engagement strategy with IVC. Along this line, the Office of Urban anthropology is preparing data for the intervention areas prioritized in the urban lab, both to guide intervention and be used to influence decision making.

> *"All the information [geospatial] we generate needs to be useful to the community, we can arrange a visit and show all the data gathering instruments we use, we are here to contribute to the process" (City official, UL march 2022).*

The coordination team of IVC is using and adapting methodologies and approaches developed for the Buenos Aires Urban Lab for other activities such as the titling process or the environmental table. Within the framework of the Environmental Sustainability Project funded by CAF, it was also noticeable how several of the community projects used ideas discussed within the urban labs and adopted them in their proposals.

> *"Participating in UL workshops allows us to experience and appropriate tools, workshop methodologies and incorporate themes that contribute and elevate discussions in other participatory spaces such as at the MGP as we initiated work around titling" (City official, may 2022).*

Final reflections

This paper has covered the social setting, methods and tools used to initiate mind-shifts that drive transformative climate resilience in Villa 20. We looked into the specific context and problems of an informal settlement, such as Villa 20, and explained the tools and methods used (bilateral meetings, urban lab workshops, tool box, funding of initiatives, generation of data, site visits, etc.) to generate mind-shifts and introduce NbS as a mean to gain equity and climate justice as well enhancing climate resilience in marginalized urban social contexts. We also presented the Buenos Aires urban lab as a place where we can both follow transformative change and use it as a tool to generate mind-shifts and coalition building.

The TUC program is providing an opportunity to debate themes that were almost absent in the discussions and implementation of the re-urbanization process, and even from city planning at large.

We cannot ascribe mind set changes to TUC alone as many programs and initiatives are being implemented in the city and within Villa 20 that contribute to generate new discussions and practices that directly and indirectly modify mind sets. Also, news and social media constantly bring attention to climate change and environmental problems. However, within this brief period we have seen that many of the actors involved with TUC often begin to relate addressing pressing needs regarding housing, infrastructure and services (part of the re-urbanization process) with NbS and climate change adaptation and mitigation goals. Also, a recognition that these themes can be discussed and acted upon in marginalized urban settings, not something for the "formal" city, contributing to address re-urbanization with climate change adaptation and mitigation in mind. And how this integration can, in fact, potentiate positive results, offering a kind of win-win situation. Essential to our research is to gain understanding on how to support processes that trigger mind-shifts toward decarbonization and transformation, and the central role played by "participation." This small but significant changes are registered during interviews, field visits, meetings and ULs.

All participants at the Buenos Aires Urban Lab are learning by doing, finding an opportunity to innovate and collaborate with climate resilient transformation in mind. The ULs have opened a participatory space where new actors are getting involved and contributing to the ongoing re urbanization process, ideas are circulated that elevate and potentiate discussions. Initial results suggest, following Bahadur and Tanner (2014), that initiatives that transform must understand climate resilience from the perspective of those who are part of the process, challenging ways of thinking and working. The integration of NbS and BGI measures that are low-tech and modular allow for a more direct involvement of neighbors along all the process, from co – design to actual implementation and maintenance.

In an attempt to summarize enabling factors that have contributed to initiate mind set changes we highlight the following:

- The particular moment themes around climate resilience, climate change, decarbonization and the use of measures such as NbS is brought to the discussion and how it is consciously presented as contributing to overall neighborhood improvement.
- The decision that weekly participatory discussion tables that oversee the reurbanization process were allocating equal time between overall technical issues and environmental issues.
- Having financial resources to actually implement, something concrete with physical results that contributes to anchor transformation.
- The possibility to be part of the implementation. Interventions will be implemented by community groups generating employment opportunities and developing capacities.
- Good working relationships between participating actors and established procedures, built over years, which allowed for an easy incorporation of new actors.

- Visibility, most actors involved take advantage of the visibility that a project such as this can generate to further bring change and support to the neighborhood.

There are many practical challenges ahead, in particular, the long-term maintenance of the interventions, and scaling up sustaining coherence between future interventions and urban policies. We expect that the process developed will generate the needed mind-shifts and create collaborations between actors to overcome these challenges.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

JH wrote first draft of the manuscript. JH and DK edited final version. All authors contributed to sections, contributed to design of the research, read, and approved submission.

Acknowledgments

This research is part of Transformative Urban Coalitions: Catalyzing Urban Partnerships to Drive Systemic Transformation Toward Sustainability (TUC) of the International Climate Initiative (IKI). Program number: 20_I_377_Lateinamerika_M_Transformative Urban Coalitions. Authors also acknowledge the support of all Buenos Aires Urban Lab participants.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 21 November 2022
DOI 10.3389/frsc.2022.928230

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 25 April 2022
ACCEPTED 31 October 2022
PUBLISHED 21 November 2022

CITATION
Malloy JT, Ashcraft CM, Kirshen P, Safford TG, Aytur SA and Rogers SH (2022) Implementing just climate adaptation policy: An analysis of recognition, framing, and advocacy coalitions in Boston, U.S.A. *Front. Sustain. Cities* 4:928230. doi: 10.3389/frsc.2022.928230

Implementing just climate adaptation policy: An analysis of recognition, framing, and advocacy coalitions in Boston, U.S.A.

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Cities face intersectional challenges implementing climate adaptation policy. This research contributes to scholarship dedicated to understanding how policy implementation affects socially vulnerable groups, with the overarching goal of promoting justice and equity in climate policy implementation. We apply a novel framework that integrates social justice theory and the advocacy coalition framework to incrementally assess just climate adaptation in Boston, Massachusetts in the United States. Boston made an ambitious commitment to address equity as part of its climate planning and implementation efforts. In this paper, we evaluate the first implementation stage over the period 2016–2019 during which Boston developed coastal resilience plans for three neighborhoods. Despite Boston's commitment to equity, we find injustice was nevertheless reproduced through representation and coalition dynamics, the framing of problems and solutions, and a failure to recognize the priorities and lived experiences of city residents. The assessment framework presented can be adapted to evaluate how other climate adaptation initiatives advance social justice and highlights the need for incremental evaluation over short time periods to inform ongoing implementation efforts.

KEYWORDS

just climate adaptation, Advocacy Coalition Framework (ACF), social justice, climate policy, Climate Ready Boston, public policy implementation

Introduction

The simultaneous climate, COVID-19, racial injustice, and economic crises demonstrate the intersectional, syndemic nature of public policy challenges and the risks of reinforcing existing vulnerabilities among already disadvantaged populations. There is an urgent need to adapt to climate change paired with a moral imperative to identify mechanisms that contribute to just and equitable adaptation outcomes for those affected most by climate impacts. In response to these needs, climate adaptation research increasingly includes an explicit focus on social justice in climate adaptation, on identifying systemic causes of social vulnerability, and on just adaptation. We define just adaptation as a process of systematically removing institutional barriers that disproportionately burden some groups of people more than others, while simultaneously creating opportunity and reducing harm related to climate change (Schlosberg, 2012; Anguelovski et al., 2016; Shi et al., 2016; Holland, 2017; Malloy and Ashcraft, 2020). We find, however, that scholarly attention to just adaptation has predominantly focused on how adaptation planning processes account for concepts of justice (Anguelovski et al., 2016; Chu and Cannon, 2021) and often fail to prioritize adaptation strategies or provide sufficient guidance on implementation (Woodruff and Stults, 2016; Olazabal et al., 2019; Turek-Hankins et al., 2021). In this paper, we build on this critical body of research about *what is needed* for just adaptation, to develop a research approach for *how to evaluate* the implementation of socially just climate adaptation policy. We apply this methodology in three urban neighborhoods in Boston, U.S.A., East Boston, Charlestown, and South Boston, where equity is an explicit goal of implementing climate adaptation policy.

Research design and methodology

A goal of this research was to respond to the need for clearer guidance for researching implementation (Hupe, 2014) by advancing a methodology that can provide insights to inform ongoing efforts. Our approach responds to the evaluation challenges of identifying stages or decision points in the implementation process to assess (Pressman and Wildavsky, 1984) and of identifying metrics that can be observed to evaluate successful implementation. We therefore begin by identifying generalized stages that, based on our experience with climate adaptation projects, can be commonly identified in initial project implementation, including in Climate Ready Boston. These initial stages typically occur over a relatively short time frame, which is appropriate for evaluating whether social justice is being integrated in climate policy implementation to inform ongoing efforts through an adaptive approach (Malloy and Ashcraft, 2020). Applying a framework that integrates social justice into elements of the Advocacy Coalition Framework (ACF) to center equity and justice as explicit goals of actors implementing climate adaptation policy, we then identify key variables, observable metrics, units of observation and possible data sources evaluators can use to assess whether and how social justice is being implemented in climate adaptation implementation processes. We apply the approach to a case study of climate policy in Boston, focusing on the plan development stage. While all processes are different, the approach we present is intended to provide a starting point for evaluators to develop further, adapt, and apply to evaluate integration of social justice in other climate adaptation initiatives.

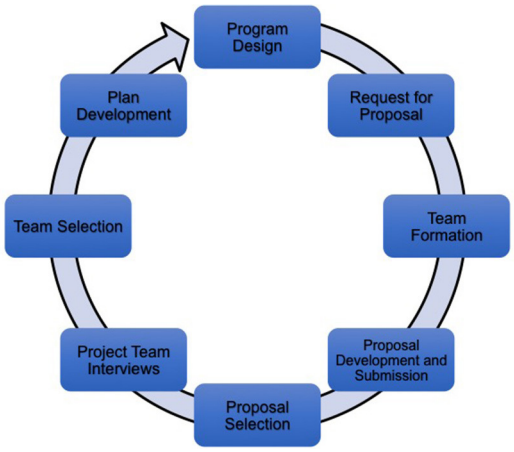

FIGURE 1
Common stages of a just climate adaptation policy implementation process.

Common implementation stages of climate adaptation policy

Pressman and Wildavsky's (1984) chain metaphor represents policy implementation as a series of interconnected, or linked, decision-points, each of which introduces new actors, decisions, or processes that ultimately influence the outcome of stated policy goals. Figure 1 identifies common decision points in the public bid and implementation process which, based on our analysis, typically occur when a public entity secures funding to implement a policy and contracts with consultants to carry out various project tasks, such as data collection and analysis, engineering design, community engagement, and report preparation. Below, we describe what we would expect to observe at each policy decision point if socially just climate adaptation is integrated into implementation.

Program Design: A policy is developed by a public entity, which aims to achieve its goals through a series of projects (also called programs). Institutional norms related to social justice influence the development of the adaptation policy.

Request for Proposal (RFP): The public entity outlines the project goals, including social justice and equity goals, and solicits the development of proposals from potential consultants.

Team Formation: Project teams are formed, consisting of several public, private, and academic entities and including just adaptation stakeholders and partnerships, whose skill set collectively meets the RFP's objectives.

Proposal Development and Submission: Project teams develop and then submit to the public entity written proposals outlining how they intend to meet the objectives of the RFP, including social justice and equity goals, and present a project timeline, a qualifications package, and the cost of project work.

Proposal Selection: The public entity reviews project proposals based on an established set of project criteria, which include proposal completeness, including capacity to meet social justice and equity goals, project team qualifications, and proposed cost to conduct the project. The public entity selects a few "short-listed" project teams they consider best suited to completing the project.

Project Team Interview: The public entity invites "short-listed" project teams to present their project approach and qualifications in an interview-style setting, which often includes responses to provided interview questions or topics to address that explicitly align with the goals and objectives of the project, including social justice and equity goals.

Team Selection: The public entity selects a "winning team" based on the project criteria. Legal processes occur, such as the drafting of contract documents, negotiations over price, and the identification of potential conflicts of interest.

Plan Development: The project team conducts the work as agreed upon, which include public engagement and planning processes.

Unfortunately for policy evaluation, data about the implementation stages from team formation through team selection are often not publicly available. In fact, transparency emerges as one way a climate adaptation implementation process can demonstrate its commitment to just adaptation, for example by making submitted proposals, proposal evaluation criteria, and other key documents publicly available. Out of necessity because of the availability of data, this research focuses on evaluating the plan development stage. In comparison to other stages in which the public entity is the primary actor, plan development is an appropriate implementation stage for our analysis because a range of stakeholders are active, and their coalition dynamics can be analyzed. If information were available, team formation would be another appropriate implementation stage in which to evaluate coalition dynamics.

Observable metrics for evaluating just adaptation

This research focuses on three key requirements for implementing just adaptation policy, which were identified through the first synthesis of the ACF with elements of social justice theory to understand just climate adaptation (Malloy and Ashcraft, 2020). The ACF is a commonly used framework for analyzing public policy choices that centers the role of coalitions and political contestation and is well suited to understanding climate change policy choices (Sabatier and Mazmanian, 1980; Jenkins-Smith et al., 2017; Gabehart et al., 2022). Integrating elements of social justice theory with the ACF advances emerging research into how the framework can be used to understand the normative dynamics of climate change politics (Gabehart et al., 2022) and, importantly, centers equity and justice as explicit goals of implementing climate adaptation policy.

First, just adaptation requires that socially vulnerable people are represented in decision processes and have agency over the decisions that affect them. Based on the definition used in climate adaptation and racial equity planning in Boston (Martin, 2015; COB, 2016a, 2017a), we define social vulnerability to include people at susceptible life stages (e.g., pregnant women, elderly, children), people with existing health conditions (e.g., chronic disease, disability), occupationally exposed people (e.g., lack of access to safe jobs, language barriers, or transportation to employment), people disadvantaged by race, ethnicity, socio-economic status, and people living in vulnerable locations. Policy actors can be identified by their participation in advocacy coalitions, alliances held together by shared beliefs about desirable policy goals (Weible and Ingold, 2018), such as whether the goals of climate adaptation policy should be resilience, equity, or transformation (Malloy and Ashcraft, 2020). Coalition participants aim to use their varying sources of power and financial resources to establish institutional rules, resource allocations, and influence the outcomes of government policy and programs (Sewell, 2005). Coalition participants can be identified in a variety of ways, including actors with authority to make policy decisions, actors who influence policy decisions, actors known to be influential in a policy subsystem, and latent actors who often include disadvantaged populations who are threatened by or the target of policy and may not be mobilized. Importantly for this research, coalitions can exclude other actors from the policy process. Individuals typically participate through their affiliation with an organization and may be more constant or sporadic participants in advocacy coalitions (Weible and Ingold, 2018). Common policy actors in climate policy include city officials, consultants from the private sector, academia, and non-profit organizations, funding agencies, civil society groups, regional utility providers, and private sector business leaders. Once identified, advocacy coalitions can then be broadly

distinguished as for or against change by analyzing their core beliefs, organizational missions, and strategic interactions (Weible and Ingold, 2018). Because both representation and agency are critical for evaluating just adaptation, this research applied elements of the ACF to focus on identifying whether policy actors who advocate for social justice and representatives of socially vulnerable stakeholder groups are represented in the membership and leadership positions of decision bodies to make project decisions and influence public outcomes, including project teams and steering committees created by public entities.

Second, just adaptation efforts frame adaptation as transformation by explicitly identifying causes of systemic injustice and developing solutions aimed at addressing these causes. Framing is the process by which stakeholders contest, shape, focus, organize, construct, and represent interpretations of the world (Chong and Druckman, 2007). How coalition participants frame adaptation efforts reflects their beliefs about what should be the goals of climate adaptation policy. In addition to transformation, common framings of climate adaptation are resilience, which frames the goal of adaptation as functional persistence (Davoudi, 2012), and equity, which frames the goal of adaptation as distribution of costs and benefits (Hughes, 2013; Doppelt, 2017; Malloy and Ashcraft, 2020). Analyzing framing provides insight into whether coalition participants express goals that focus on causes of injustice and whether adaptation efforts maintain a focus on advancing justice. Climate adaptation projects often document information about how different stakeholders view problems and solutions, for example through records of comments at public participation opportunities or reports synthesizing participants' comments about problems and solutions.

Third, just adaptation efforts recognize the priorities and needs of socially vulnerable groups, develop the capabilities of just adaptation stakeholder groups to engage, and are perceived as just by socially vulnerable groups. Building the capabilities of socially vulnerable groups to exert agency in climate adaptation processes, in turn, influences who is represented in advocacy coalitions (Nussbaum, 2011). Evaluating recognition provides insight into whether participation by advocacy coalitions focused on social justice has an impact on outcomes. Recognition can be evaluated by analyzing whether project documents, such as project objectives and evaluation criteria, reflect the framing of adaptation efforts, priorities, and needs of socially vulnerable groups (Chong and Druckman, 2007), whether public engagement opportunities are designed to shape project development or only to educate the public (Shi et al., 2016), whether project resources are allocated to foster full participation of socially vulnerable groups, and by how socially vulnerable individuals perceive the implementation process.

Based on the three criteria, we defined observable metrics and units of observation by which to evaluate just adaptation efforts and identified possible sources of information (Table 1).

Case study: Climate Ready Boston

This research used a qualitative case study design to evaluate the City of Boston's ongoing climate adaptation initiative, Climate Ready Boston (CRB), which has an explicit commitment to foster equity. Metropolitan spaces are well suited to just adaptation research as they reflect contested governance between diverse public and private sector interests spread over broad geographies of interconnected and urgent public policy issues, including social justice, transportation, food, affordable housing, environmental issues, and economic development. Boston joined other U.S. urban areas in developing an ambitious climate adaptation initiative to respond to the intersectional challenges of climate change impacts from extreme heat, sea level rise, precipitation and storm events and social justice issues (COB, 2016a). Residential segregation, economic inequality, gentrification, and other forms of systemic racism have made Boston one of the most inequitable cities in the U.S., which is reflected in the City's landscape and vulnerabilities (COB, 2018). As a result, like many other coastal cities around the world, Boston is experiencing rapid rates of development in areas highly vulnerable to the effects of climate change (Shi, 2020; Shi and Varuzzo, 2020).

After a near miss from Hurricane Sandy in 2012, Boston Mayor Menino's administration established CRB as a joint initiative with the City of Boston and the Green Ribbon Commission, an existing commission focused on climate mitigation and, later, adaptation. According to CRB's citywide RFP (COB, 2015), CRB aimed "to prioritize initiatives that weigh stakeholder input, feasibility, scalability, adaptability, demonstrated effectiveness, climate mitigation contributions, co-benefits (e.g., job creation, green space, regional impacts), resilience and other factors" (COB, 2016b). By 2016, CRB was developing a citywide vulnerability assessment (VA) at the same time as Boston was engaged in Imagine Boston, the first citywide master planning effort in 50 years, and Resilient Boston: an Equitable and Connected City, a racial equity resilience plan to guide Boston to a more affordable, equitable, connected and resilient future (COB, 2017a,b).

CRB focused on three major climate hazards: extreme heat, stormwater flooding, and coastal and riverine flooding and included robust coastal flood risk modeling (Bosma et al., 2015) to analyze flooding impacts on people, buildings, infrastructure and the economy, such as economic loss or percent land area impacted, and included analysis of impacts on categories of socially vulnerable groups in the City. Preliminary vulnerability assessments in each Boston neighborhood were then refined through neighborhood-scale resilience planning efforts. As shown in Figure 2, following the CRB VA, implementation moved forward with the selection of the first neighborhood-scale resilience planning efforts: East Boston, Charlestown, and South Boston. East Boston and Charlestown were combined into a single planning effort. The first implementation stage

TABLE 1 Variables, observable metrics, units of observation, and potential data sources for just adaptation evaluation.

Variable: Observable metrics	Units of observation	Potential data sources
Advocacy coalitions: Policy actors who participate in decision-making	Representation (presence or absence) of just adaptation coalition actors (actors who advocate for social justice and representatives of socially vulnerable stakeholder groups) in the membership and leadership positions of decision bodies Interactions between adaptation coalition and just adaptation coalition actors	Project team information in proposals; Committee membership information in project reports; Lists of participants in RFP decisions in decision summaries; Interviews with project participants and interested and affected parties; Participant observation at project events; News and media reports identifying participants in decision bodies or key project events
Framings: Definitions of problems and solutions	Information about how just adaptation coalition actors define project problems and solutions	Infographics, documentation of public comments, and other public engagement information included in project reports; Interviews with project participants and interested and affected parties; Participant observation in public engagement events; Stakeholder statements in news and media reports about project objectives and solutions
Recognition: Framings in project elements (e.g., project objectives, evaluation criteria) Capabilities Perceptions of the implementation process	Inclusion of just adaptation coalition actors' framings and priorities in project goals and evaluation criteria; Design and purpose of public engagement to influence project development and outcomes; Resources to foster robust engagement of just adaptation coalition actors; Perceived just adaptation by just adaptation coalition actors	Statements of project objectives, evaluation criteria and their use in analyses; Public engagement goals and methods, and use of public knowledge and input in RFP; Project team proposals, interim and final reports; Allocation of budget and capacity building resources to support participation; Interviews with project participants and interested and affected parties

then advanced quickly from RFPs and proposal selection, the development of evaluation frameworks, and public engagement to the development of conceptual resilience design strategies (also known as a 30% conceptual design level), which typically include visual renderings but only limited engineering criteria. This research, conducted from 2016 to 2020, focuses on the initial implementation stage in the first two resilience planning efforts for the three selected neighborhoods.

Starting with the approach described in Table 1, we identified and analyzed publicly available data sources:

- Climate Ready Boston's final report, the vulnerability assessment for the City of Boston
- CRB Request for Proposals (2): the RFP for Charlestown and East Boston and the RFP for South Boston
- Consultant team proposal: the winning consultant team proposal for South Boston was the only publicly available proposal
- Neighborhood scale coastal resilience plans (2): the Charlestown and East Boston Adaptation Plan and the South Boston Adaptation Plan
- CRB media, including news sources, emailed newsletters, infographics and documents used to communicate online survey and public engagement outcomes
- Imagine Boston 2030, the master planning document for the City of Boston
-] Resilient Boston: an Equitable and Connected City, the racial equity plan for the City of Boston

We also conducted 18 semi-structured interviews between March 2019 and September 2020 (after neighborhood-scale coastal resilience plans were published) with representatives from city government, the non-profit sector, neighborhood organizations, the private sector, and academia. Interviewees were identified through purposive snowball sampling, beginning with stakeholders identified in CRB reports, digital media, recorded public informational sessions, and public meeting transcripts. Transcripts of recorded interviews were analyzed using NVivo software and a codebook, which was based on Table 1, developed through an iterative, hybrid inductive and deductive approach, and improved through intercoder reliability testing (see Malloy, 2021 for additional details on the interview and analysis process, the codebook, and interview protocol). Data were also collected through participant observation of citywide climate events focused on CRB and one South Boston open house event. Data involving human subjects were collected in accordance with UNH Institutional Review Board Approval #7068.

FIGURE 2
Climate Ready Boston important dates.

Results

Advocacy coalitions: Representation of just adaptation coalition on CRB decision bodies

Among the many interested and affected parties engaged in implementing Boston's climate resilience plan, we identified two distinct advocacy coalitions: the "adaptation coalition" and "the just adaptation coalition". The adaptation coalition included municipal leaders representing powerful interests throughout Boston and private sector consultant teams with expertise in modeling complex climate conditions and developing comprehensive planning documents. Although formally responsible for implementing policy, municipal leaders relied heavily on the well-resourced consultants, with whom municipal leaders often had long-standing relationships. The just adaptation coalition included actors representing neighborhood organizations, community advocacy groups, and project funding partners loosely allied through a shared focus on social justice and a framing of the goal of climate adaptation as transformation. Just adaptation coalition participants were engaged in policy issues at the intersection of climate change and social justice, issues which have historically been addressed separately. For example, community groups in East Boston, a neighborhood that has seen decades of economic stagnation and development pressures related to Logan Airport, were focused on affordable housing or reliable transportation, and integrated climate adaptation in their work as a subset of these goals. In contrast to the adaptation coalition, just adaptation coalition participants operated in a more decentralized way and had fewer resources, including financial resources, time, technology, and access to media and political leadership. The coalition also included less mobilized actors from socially vulnerable groups, who are the target of CRB policy and participated in public engagement opportunities. While both coalitions can be considered advocates for climate adaptation policy, their framing of policy goals differed (discussed in the section on framing climate adaptation). In this section we analyze whether just adaptation coalition participants were represented in the membership and leadership positions of two kinds of decision bodies: the neighborhood Steering Committees and the Infrastructure Coordination Committee, which was proposed but never created.

TABLE 2 Organizations participating on CRB steering committees (Sources: COB, 2016a, 2017c, 2018).

Climate Ready Boston Vulnerability Assessment	
Boston Environment Department	Boston Planning and Development Agency
MA Office of Coastal Zone Management	Boston Green Ribbon Commission
East Boston and Charlestown Resilience Plan	
Boston Environment Department	Boston Planning and Development Agency
Boston Parks and Recreation Department	Boston Public Works Department
Boston Transportation Department	Imagine Boston 2030
Boston Water and Sewer Commission	Boston Green Ribbon Commission
Mayor's Office of Neighborhood Services	Mayor's Office of Resilience and Racial Equity
Neighborhood of Affordable Housing (NOAH)	UMass Boston School for the Environment
City of Cambridge	City of Somerville
MA Office of Coastal Zone Management	MA Port Authority
MA Department of Transportation	
South Boston Resilience Plan	
Boston Environment Department	Boston Planning and Development Agency
MA Office of Coastal Zone Management	Boston Green Ribbon Commission

Each neighborhood initiative had a Steering Committee, which was largely responsible for implementing CRB. For example, South Boston project's RFP described the Steering Committee's leadership role in decisions, "the project will be under the direction of the Steering Committee" and "the consultant team should vet identified options with the Steering Committee and interviewed stakeholders before proceeding to community engagement" (SB RFP). Table 2 depicts the organizations represented on the Steering Committees for the first two planning efforts, as well as for CRB's VA.

A small group of organizations participated across each initiative and, as numerous interviewees pointed out, neighborhood-based social justice actors were largely absent from the Steering Committees. As one just adaptation coalition participant highlighted, "I think what is a challenge for that is most of the groups that are operating in the climate adaptation, climate resilience space are not organizations that are particularly racially diverse, don't particularly have any kind of racial justice analysis or tool to understand…" While advocates for racial justice and broader social justice exist, this quote highlights the separation between the policy spaces within which they and the adaptation coalition typically work.

The Neighborhood of Affordable Housing (NOAH) in East Boston stands out as a just adaptation coalition member that participated in a key decision body. NOAH is an East Boston-based non-profit organization focused on affordable housing initiatives and related programs. In recognition of NOAH's reputation in East Boston and dedication to climate preparedness efforts, the City of Boston specifically named NOAH as a Steering Committee member of the East Boston neighborhood planning project. The East Boston RFP called for the selected consultant team to partner with NOAH's ClimateCARE initiative to lead community engagement. However, in contrast to the consultant team, NOAH received no funding from the City for its implementation work. Despite NOAH's position on the Steering Committee, East Boston community advocates reported they felt NOAH was excluded from decision-making processes, had no opportunity to contribute to substantive project outcomes, and that NOAH's role in CRB's community engagement activities was limited to invitations to participate. This example illustrates why representation alone is insufficient for sustaining a focus on social justice in the implementation process.

The Infrastructure Coordination Committee (ICC) represents another missed opportunity for representation of just adaptation advocates. Developing the ICC emerged as a key recommendation of CRB's citywide VA to advance equity. During CRB's VA process, Boston residents identified access to transportation and communication networks as key concerns. An Infrastructure Advisory Group was formed with representatives from the water, sewer, transportation, energy, and telecommunication sectors. CRB's VA identified coordination of Boston's complex, interdependent infrastructure systems as an issue, noting that the City lacks "direct control over all of the infrastructure that serves its population and economy, relying partially on regional systems" (COB, 2016a, p. 118). The ICC was to be responsible for coordinating collaborative planning efforts across infrastructure system providers and for developing adaptation plans in accordance with design standards that "advance equity and protect socially vulnerable populations". According to CRB's final report, "The city should charge ICC members with paying particular attention to vulnerable populations who may be disproportionately impacted by full or partial infrastructure failure" (COB, 2016a). However, as of this writing, the City hasn't established the ICC. According to a City representative, the City still intends to form the ICC to support future CRB implementation, but its formation has been impeded by the lack of a framework for doing so. In the meantime, the absence of the ICC represents a missing space for advocacy coalitions to engage on a key concern identified by Boston residents.

CRB's neighborhood engagement efforts and recognition

In the earliest stages of CRB, Boston made a commitment to public engagement. CRB's community engagement strategies are summarized in Table 3.

Although CRB's citywide VA process involved limited community engagement, the process drew on data from the robust community engagement efforts that were part of the concurrent Imagine Boston 2030 and Resilient Boston initiatives (COB, 2017a,b). As the City shifted its focus from vulnerability assessment to neighborhood resilience planning in East Boston, Charlestown, and South Boston, the City expressed an explicit commitment to engaging the public and responding to community social justice needs. For example, according to the East Boston and Charlestown RFP

"*These coastal resilience strategies should be rooted in principles of adaptive design over time, nature-based storm damage protection techniques, community resilience, and coastal restoration and will be developed through a more extensive community engagement process to ensure the project addresses neighborhood needs and improves resiliency for multiple stakeholders…In particular, public engagement will aim to expand potential project co-benefits to issues such as equity, reduced social vulnerability, enhanced waterfront access, and economic development in areas directly flooded as well as those areas more indirectly impacted (such as by cascading impacts).*" (COB, 2016b).

During implementation, most CRB community engagement efforts were primarily structured to educate community participants, instead of to influence project outcomes. In open houses, project stakeholders from the City and project consultant teams provided information about project goals and proposed coastal resilience design solutions to the public through presentations and posters. Organizers used mostly one-way communication methods, such as surveys and voting, to solicit feedback on preferred site amenities and evaluation criteria. Data were then compiled into

TABLE 3 Summary of community engagement strategies.

Plan	Engagement date	Engagement approach
Climate Ready Boston Citywide Vulnerability Assessment	No Significant Engagement	Drew upon Imagine Boston 2030 and Resilient Boston Community Engagement Efforts
Climate Ready Boston East Boston and Charlestown Coastal Resilience Plan	East Boston Community Workshop (5/23/2017), East Boston Open House (7/13/2017), Charlestown Open House (7/20/2017)	Project team presentations Collect demographic information and open-ended feedback of interests and priorities Push-pin exercises Ranking of concerns and priorities Community resilience game
Climate Ready Boston South Boston Coastal Resilience Plan	Online Survey (9/28/2017–12/31/2017), Open House 1 (12/11/2017), Open House 2 (3/6/2018)	Project team presentations Collect demographic information and open-ended feedback of interests and priorities Push-pin exercises Ranking of concerns and priorities Tabling (i.e., attendance) at community events to promote project

infographics, which although not included in final project reports, are publicly available on the City of Boston's CRB website. Infographics characterizing engagement forum participants were limited to gender and identifying where participants were from. Community interviewees reported they felt the engagement forums could have fostered more inclusive participation, for example by better engaging local organizations. NOAH's ClimateCare program ultimately held a separate community engagement effort in East Boston and produced a climate preparedness planning document, funded through a $100,000 grant from the Kresge Foundation to support education and adaptation planning in low-income areas in East Boston. However, the CRB's consultant team did not include outcomes from NOAH's efforts in its final neighborhood report.

Project consultants reported that the engagement processes promoted knowledge about problems and solutions and identified education as one of the most valuable engagement outcomes. However, community advocates in East Boston viewed the approach to community engagement as outreach or education as a limiting top-down engagement method where already defined and framed projects were taken to the public for feedback. Just adaptation coalition participants said there were very few, if any, examples where participants' input directly changed the subsequent process or outcomes. They would have preferred a flipped approach that allowed for more dialogue and where community stakeholders were central to the decision-making and framing process from the beginning. Instead, many interviewees described consultants as the actors with the biggest impact on the content of the final reports.

Framing climate adaptation: Evaluation criteria and lived experience

During the neighborhood engagement opportunities, project teams made up of municipal stakeholders and consultant teams, asked participants to rate their most important evaluation criteria and provide feedback through open-ended questions or voting activities about their lived experience. Table 4 summarizes information provided by community engagement participants, which was included in final reports for the East Boston, Charlestown, and South Boston neighborhood-scale resilience planning efforts. Based on our review of online survey results and community engagement infographics, we found the final project reports accurately reflected participants' input, with one exception. Participants in South Boston ranked equity as the third most important evaluation criteria, but this was not included in the final project report.

While there are slight differences in the lived experience reported by participants across planning initiatives, the same general categories are apparent, including flood protection, affordable housing, access to transportation, access to open space and the waterfront. The similarities in how comments were reported from all three neighborhoods covered by the two initiatives suggest the project team's evaluation framework dominated the engagement approach and outcomes over the participants' contributions.

The City, Steering Committee and project consultant team developed the evaluation framework in response to a call in the East Boston and Charlestown RFP for the development of a "consistent evaluation framework guided by local priorities that consistently quantify the social, environmental, and

TABLE 4 Evaluation criteria and community feedback reported in CRB neighborhood-scale resilience planning final project reports*.

Neighborhood	Evaluation criteria	Community feedback—lived experience
East Boston Charlestown	Effectiveness, Design life, Environmental impact, Social impact	Flood protection Mobility—safe and reliable transportation system Affordability—affordable housing and access to jobs Open Space—diversity of recreational and passive uses. Waterfront Access
South Boston*	Effectiveness, Environmental impact, Design life, Feasibility	Flood protection Affordable housing Parking access Protection of industrial areas Water dependent businesses Open space

*The South Boston final report left out equity, which participants ranked as the third most important evaluation criteria.

economic benefits of proposed resilience initiatives with particular attention to social equity and the needs of socially vulnerable populations" (COB, 2016b, p. 106). The framework evaluation criteria were effectiveness, feasibility, design life and adaptability, environmental benefits, social impact, equity, and value creation, and were to be used to help "guide and rank proposed climate resilience strategies" (COB, 2016a). CRB evaluated effectiveness based on maximum level of protection from coastal storm events, reduction in flood extents, avoided damage and loss, residents protected, and critical assets protected. CRB defined feasibility as stakeholder acceptance, constructability, permitting, affordability: cost of construction and maintenance, and replicability. A project decision-maker with the City described the framework as focused on reducing flooding over addressing other community concerns.

The purpose of developing consistent evaluation criteria was to serve more as a guiding principle, to better understand who is going to be affected by flood hazards and how to prioritize projects to protect the city, and less of a framework or evaluation tool to make strong decisions, such as issues surrounding green gentrification, housing, or ownership of vulnerable spaces.

While measures of feasibility and effectiveness provide useful information, and of course need to be considered when evaluating flood protection measures, other more innovative measures of social vulnerability were less represented or absent altogether from project outcomes. Many interviewees for this research described the solutions that were proposed following the neighborhood planning efforts as projects that respond to predefined flood pathways, which fit the criteria of feasibility and effectiveness, but also as projects that don't respond to community priorities and sources of vulnerability identified through the neighborhood planning processes. For example, the proposed solution for Charlestown was to raise a roadway along a defined flood pathway, which is a state transportation project that has been pending long before CRB began. An interviewee commented that residents considered raising the roadway to be a limited solution to present day flood vulnerability that won't address persistent risks related to sea level rise and rising tides in residential neighborhoods. Similarly, an interviewee from the City described East Boston's proposed deployable flood barrier as a "shovel ready" project and as a cost effective and immediate measure to "protect everyone equally". In contrast, East Boston neighborhood residents and just adaptation advocates described the proposed solution as a missed opportunity to engage in dialogue, educate the community about ongoing climate resilience efforts in the city, and provide co-benefits for residents, such as improving access to safe and reliable transit options or affordable housing. Project teams prioritized effectiveness and feasibility over equity, social impact, or environmental benefit, which diminished the considerations of socially vulnerable groups and undermined the role of the engagement efforts. While an important outcome across the neighborhoods was improved access to open space and the waterfront, because this outcome already aligns well with flood protection measures, it doesn't represent a new framing that centers social issues. Instead, the adaptation coalition's framing of project goals as reducing flooding dominated just adaptation coalition members' more transformative framings.

In another example, the first neighborhood-scale RFP (issued 2 months before publication of Boston's vulnerability assessment) combined East Boston and Charlestown into a single planning initiative. The decision focused on the neighborhoods' similar climate risks, ignoring differences in their sociodemographic characteristics or priorities. As stated in the RFP, the decision was intended to "advance the development of interventions at two critical coastal flood pathways for the city" because these locations "are currently at risk from 1% annual chance of flooding, have high concentrations of vulnerable residents and critical infrastructure, and are affected by relatively narrow and well-defined flood pathways"

(COB, 2016b, 2017d). As a result, the final project report combined community engagement input from East Boston and Charlestown, which prevented community needs and sources of vulnerability specific to either neighborhood from informing project solutions. Table 5 summarizes our observations of how justice was not sustained during the first implementation stage.

Discussion

In this research we first identified two distinct coalitions defined by different framings of climate adaptation goals as resilience or transformation (Malloy and Ashcraft, 2020). Members of the adaptation coalition saw flood pathways as the main adaptation challenge to be addressed and technical criteria, especially effectiveness and feasibility, as primary considerations for evaluating projects. Adaptation coalition organizations coordinated their actions closely. They also had resources, including scientific and technical expertise, their own financial resources or funding from others, and access to political leadership, to support their implementation work. In contrast, we identified members of the just adaptation coalition based on participants' shared beliefs in transformation as an adaptation goal. They viewed flooding as only one part of the climate adaptation challenge, along with access to jobs, mobility, affordable housing, and open space, for example. They considered the extent to which projects provided co-benefits across interconnected issues as primary criteria for evaluating projects. Just adaptation coalition participants had fewer resources to support their implementation work, included latent members who mobilized only occasionally for policy action, and coordinated more loosely with one another to advance broader social justice goals.

Our analysis revealed three interrelated procedural features that reinforced reliance on technical and policy experts of the adaptation coalition to the detriment of socially vulnerable groups in the just adaptation coalition (Webster et al., 2022). First, we found CRB decisions tended to reinforce dominant coalition dynamics that favored elite interests and exacerbated power inequalities. CRB aimed to foster inclusive implementation by naming a just adaptation coalition actor, NOAH, to a decision-making group, by recommending that an important proposed infrastructure committee consider equity as a dominant feature in decision-making, and through community engagement forums that could provide opportunities for less mobilized just coalition actors to influence policy. However, steering committees lacked substantial representation from just adaptation coalition participants. Even with representation on the steering committee, NOAH, the primary participant representing socially vulnerable groups, received no funding for its implementation efforts and was relegated to a peripheral role. The Infrastructure Coordination Committee was never formed. As a result, we find that the just adaptation coalition was largely excluded from influencing policy. Consistent with other research on urban adaptation planning, advocacy coalitions' competing interests and decision processes constrained the inclusiveness of adaptation efforts (Chu et al., 2017).

Community engagement is a common aspect of climate adaptation planning and is generally used as another mechanism to promote representation and equitable project outcomes. However, CRB community engagement opportunities were not well coordinated with neighborhood groups and there was little reporting on how robust participation in forums was from socially vulnerable groups, with the notable exception of participants' gender. Rather than structuring CRB public engagement as effective forums to inform policy, forums included few opportunities for dialogue and focused, instead, on "thin" one-way communication methods for outreach and education (Rowe and Frewer, 2000). Thin approaches to engagement have value, but struggle to engage under-represented groups, garner public trust, and shape organizational goals (Agyeman, 2013). As a result, open houses and public listening sessions are often criticized as merely checking a box so project teams can meet public contract requirement while advancing already defined project goals and proposed solution. As we saw in CRB, project team participants are typically already privileged, for example by being paid through municipal contracts, which risks delegitimizing outcomes from the perspective of less resourced actors, especially when social justice advocates are unpaid for their implementation work (Fung, 2006; Tschakert et al., 2013). Relying on subject matter technical expertise, such as modeling or cost-benefit analysis, is necessary and important for complex adaptation processes, but can dominate the stated needs of community residents or their representatives, as we found in CRB's implementation, risking the legitimacy of these processes (Few et al., 2007; Jasanoff, 2018). In a place like Boston, where there is a history of vulnerable groups being dominated by powerful stakeholders, an approach that centers technical experts over residents further erodes trust (Eriksen et al., 2015).

Finally, we found that the adaptation coalition's dominant framing of problems based on flood pathways and reliance on a technocratic evaluation framework favored pre-determined outcomes focused on flood mitigation designs that missed opportunities for co-benefits to address other priorities of the just adaptation coalition. The decision to combine East Boston and Charlestown in the first implementation project shows how framing the goal of adaptation as resilience trapped implementation decision-making in a science and policy focused framing implementation over social justice concerns. The decision to focus on feasibility and effectiveness was intended to support the development of district-scale flood mitigation strategies and establish a consistent evaluation framework through neighborhood scale implementation efforts. In doing so, it also pre-defined, and shifted, the planning

TABLE 5 Evaluation of just adaptation in Climate Ready Boston's first implementation stage.

Variables	Observations
Advocacy coalitions	Representation on steering committees: adaptation coalition participants dominated; Only one neighborhood just adaptation coalition participant (NOAH) participated, and its implementation work wasn't funded by CRB
	Infrastructure Coordination Committee wasn't formed
	Public engagement forums didn't partner with local organizations; Participation in forums from socially vulnerable individuals wasn't reported other than gender characteristics
Framings	Adaptation coalition problem framings (flood pathways) dominated just adaptation coalition priorities and lived experiences; East Boston and Charlestown neighborhoods were combined into a single project
	Framework developed by adaptation coalition dominated project evaluation over just adaptation coalition's interests in co-benefits; South Boston final report omitted equity as an evaluation criterion prioritized by engagement participants
Recognition	Public engagement forums were organized for outreach and education; One-way communication methods dominated engagement forums
	Consultants had primary influence on final reports; Input from public engagement forums had minimal influence
	East Boston and Charlestown final report excluded outcomes from engagement effort led by neighborhood just adaptation coalition participant (NOAH)

focus away from the priorities of the just adaptation coalition. Feasibility analysis, which includes measures of effectiveness, is a common approach in planning and engineering disciplines that establishes dominant criteria for assessing the viability of a land use development project. However, evaluation criteria that emphasize feasibility and effectiveness are very different decision-making tools, as compared to community feedback about lived experiences (Adger, 2016). While in practice, the use of a consistent evaluation framework may help to reconcile the too-many variables problem common in policy implementation (Pressman and Wildavsky, 1984), in CRB we see how this approach replaced the hard work necessary to engage with the just adaptation coalition in a manner that influenced project design (Adger et al., 2005). A dynamic approach is needed that reconciles evaluation criteria focused on project outcomes and contextual framings based on neighborhood social justice needs to support broader stakeholder representation and meaningful procedural justice (Van den Berg and Keenan, 2019).

Based on our review of the first three years of the implementation of Climate Ready Boston, we found that Boston's commitment to incorporate equity into neighborhood-scale planning was overshadowed by a traditional, mainstreamed approach to policy implementation that built on existing planning approaches, similar to what has been observed in other studies (Chu et al., 2017). Language in RFPs and other documents provide evidence of the city's commitment to a process rooted in concepts of procedural justice and recognition, which aimed to include considerations of social vulnerability, such as the cultural or symbolic value of what is being affected (Adger, 2016). However, consistent with other urban adaptation research, our analysis of the first stage of implementation found that decision-points in the implementation process reinforced unjust outcomes for socially vulnerable people through mainstreamed planning processes (Uittenbroek et al., 2013; Van den Berg and Keenan, 2019).

Conclusions

As scholars increasingly pay attention to the implementation of climate adaptation policy, we argue that climate adaptation efforts must be evaluated on short, incremental timeframes in order to identify ways in which justice is or is not fostered during implementation. Planning efforts following a policy decision, such as the preparation of vulnerability assessments or resilience plans, should be evaluated as a fundamental early phase of policy implementation. Evaluation results can then inform rapid and ongoing implementation initiatives. For example, in comparison to the first stage of implementation that was the focus of this research, Boston's CRB efforts from 2019 to 2022 show the kinds of co-learning and improvements in fostering equity that an analysis of incremental implementation stages can inform. Boston's more recent CRB efforts have advanced the resilience of the city through five "layers" that address: (1) updating climate projections, (2) building community resilience, (3) protecting the shoreline, (4) constructing resilient infrastructure, and (5) adapting buildings to climate risk (COB, 2022a). Boston expanded its resilience planning focus by preparing district-scale resilience plans in Dorchester, the North End, Downtown, and East Boston—Phase 2, developed a citywide harbor vision, and an extreme heat plan (COB, 2022b). To support implementation efforts, the City also coordinated with the City Works Department and the Boston Planning and Development Agency (BDPA) to develop climate resilient design guidelines. Resilience planning in Dorchester fostered equity, for example, by shifting the emphasis in its

planning framework from feasibility and effectiveness to the stated needs of the community. Similarly, East Boston improved the accessibility of its project resources by making them available in multiple languages, which creates an opportunity for more people to provide input. In contrast to the first implementation phase, subsequent RFPs stated that proposals would be publicly available upon request, which is critical for transparency and evaluation. Efforts that aim to implement just climate adaptation should take similar steps to increase transparency by making information available about how social justice and equity goals are integrated in each stage of the implementation process.

As we found with CRB, merely embedding goals of equity into planning documents is insufficient to achieve transformation. The risk is that failing to focus on structural conditions of inequality, such as poverty or exclusion, allows vulnerability to persist under the guise of socially just climate adaptation and distracts from building adaptive capacities (Agyeman, 2013; Bulkeley et al., 2013). Our intent is not to blame any actor or initiative; even advocacy organizations with a focus on justice can be susceptible to engaging in mainstream adaptation planning over transformative adaptation planning (Shi, 2019, 2021). Similarly, our intent is not to propose unachievable implementation standards that thwart any kind of good intentions a city may have. Instead, we aimed to develop a research approach that can be used to evaluate whether social justice is integrated in incremental climate policy implementation efforts and to inform ongoing initiatives. A focus on just adaptation coalition building, centering framings of climate adaptation problems and solutions based on lived experience of disproportionately burdened people, and representation of socially vulnerable groups and recognition are critical to achieving socially just climate adaptation, as is a commitment to policy evaluation and co-learning.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by University of New Hampshire Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

Author contributions

Research conceptualization and methodology: JM and CA. Investigation and analysis: JM. JM developed the original draft with significant writing contributions from CA. All participated in revisions. All authors contributed to the article and approved the submitted version.

Acknowledgments

The authors wish to acknowledge the insights, time and energy interview participants contributed to this research. We appreciate the thoughtful comments from two reviewers which strengthened the paper. We also thank the organizers of this special issue and author workshop participants for stimulating research discussions. All insights are the responsibility of the authors alone.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 06 January 2023
DOI 10.3389/frsc.2022.972173

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Climate Change and Cities, a section of the journal Frontiers in Sustainable Cities

RECEIVED 17 June 2022
ACCEPTED 31 October 2022
PUBLISHED 06 January 2023

CITATION
Asif F, Beckwith L and Ngin C (2023) People and politics: Urban climate resilience in Phnom Penh, Cambodia. *Front. Sustain. Cities* 4:972173. doi: 10.3389/frsc.2022.972173

People and politics: Urban climate resilience in Phnom Penh, Cambodia

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The rapid growth Cambodia has experienced over the past two decades has resulted in a dramatic transformation of its built environment, in particular, its largest city, Phnom Penh. The shape this urban development has taken echoes that of many developing countries whose urban landscape features gleaming skyscrapers, apartment buildings, and edge-city projects spread across a rapidly expanding urban area. Such a pattern of urbanization is occurring in Phnom Penh while the city faces increased flooding, lack of adequate urban infrastructure, and vulnerability to impacts of climate change. At the same time, embedded within national policy discourses of climate change and social/economic planning, and backed by international donors, are calls for strengthening or developing resilience. Yet, in the city there are signs of land dispossession, marginalization, inequality, and exacerbated poverty. In parallel to high-level discourses of urban resilience, on the ground there have been "everyday forms of resilience" that show how people enact and build resilience through collective action and advocacy for the rights of the urban poor. In reconciling this dichotomy, we argue that the continued reproduction of a technocratic-focused discourse on resilience in Cambodia by national and international actors overshadows the everyday contestations, strategies and resilience-making practices of people in urban areas. Through three examples, we showcase the varying ways in which these contestations and strategies occur in, and despite, an environment of suppression, and how they are challenging the status quo. In doing so, we shed light not only on the politics of resilience but, more importantly, the implications of the political agendas that ultimately contribute to exacerbating vulnerabilities of urban residents, even as calls continue for increased urban "resilience."

KEYWORDS

urban climate resilience, Phnom Penh, politics, Cambodia, urbanization, political and social transformations, urban resilience

Introduction

Cambodia's rapid economic growth over the past 20 years is visible across a variety of landscapes, from the macro (GDP and GNI per capita) to the micro (upward social mobility and people's wallets). One of the most visible symbols has arguably taken place in the urban landscape, particularly in the capital, Phnom Penh. At the same time, the country's growth has been geographically unequal wherein most of the wealth has been

concentrated in urban areas with rural areas seeing far less development.[1] This urban concentration of wealth started around the mid-2000s when Phnom Penh ushered in a construction boom that has resulted in the wholesale transformation of its skyline which is now dotted with towers of shimmering glass and steel. In the past decade alone, over 600 high-rises have been built (Nam, 2017a). While this pattern is more correlation than causation, especially in light of the government's role in real estate speculation and the (over)reliance on private investment (Paling, 2012; Nam, 2017a), it mirrors the kind of urban development that is occurring in other urban areas of developing countries.

Alongside the rapid urbanization of Phnom Penh are the policies put in place that promote a vision of urban development seemingly in line with ideas of "urban resilience." While no universal definition of urban resilience exists, the term/concept is understood as the processes that enhance the capacity of a city's urban systems to resist a range of shocks and stressors and maintain or quickly return to their desired functions (Davoudi et al., 2012; Meerow et al., 2016). This notion is captured in Phnom Penh's Sustainable City Plan 2018–2030 whose overall vision is "[b]y 2030, Phnom Penh will become a clean, green and competitive city offering a safe and quality lifestyle to its residents" and one of the four overall goals is to "[p]rovide urban resilience for all citizens to natural, climatic and other risks" (Phnom Penh Capital Hall, 2018, pp. 3–4). Related to this last point, there is also the Climate Change Strategy Plan 2014–2023 which includes, among its eight objectives, promoting "climate resilience through improving food, water and energy security" (p. 13); "ensure climate resilience of critical ecosystems (Tonle Sap lake, Mekong river, coastal ecosystems, highlands, etc.)" (p. 15); and "promote low-carbon planning and technologies" (p. 15) (RGC, 2013). Further, guiding the actual urban development of the capital is the Phnom Penh Master Plan (officially termed "Phnom Penh Land Use for 2035"), a 330-page document whose development was funded by the French Embassy—however access to the master plan is only possible by submitting a formal permission request to the governor (Halim, 2016). Visions of urban resilience are also reflected at the international and inter-governmental levels, e.g., United Nations' Sustainable Development Goal 11 "Make cities inclusive, safe, resilient, and sustainable" and UN Habitat's New Urban Agenda stating a vision for "resilient and sustainable cities and human settlements to foster prosperity and quality of life for all" (UN Habitat, 2016, p. 5). However, the question remains: to what extent are the goals of "urban resilience" and "climate resilience" being achieved in Phnom Penh?

On the ground, what can be observed is that urban vulnerability is compounded for city and peri-urban residents because of regular incidents of flooding, pollution, poor waste management, river bank erosion, and storm damage (Sasin and Sokha, 2015). On top of this, since the urban poor are shut out from the formal property market, they are tacitly forced to live in the parts of the city that are most vulnerable to climate change-related impacts (e.g., increased severity of flooding, erosion, etc.) such as near river banks and lakes. These areas where many of the urban poor live are also becoming increasingly vulnerable from the effects of urban development. A recent report highlighted how the development of ING City, a satellite city near Phnom Penh, is slated to fill in over 1,500 hectares of wetlands and put over 1 million people (roughly half the population of the city) at risk of disastrous floods and water pollution (Handley, 2020; STT, 2020). Studies of vulnerability to climate change have identified "hot spots" in countries around the world, including Cambodia which is listed as among those most vulnerable (151 out of 182 countries on the 2019 Global Adaptation Index) to the impacts of climate change given its low adaptive capacity (Notre Dame Global Adaptation Initiative, 2022). Put another way, Cambodia is the 36th most vulnerable country to impacts from climate change and the 33rd least ready country to face such challenges.

In attempting to reconcile the dynamics of the so-called "resilience agenda" (Leitner et al., 2018; Webber et al., 2021) at the national level with the visible lack of progress on improving urban resilience in Cambodia's capital, we argue that the continued reproduction of a technocratic-oriented narrative on resilience overlooks the ways in which this dominant discourse is being contested. By highlighting examples within civil society where people and organizations are continuing to engage in research and contribute to knowledge on urban vulnerability and the needs and actions of urban citizens, we show how these practices not only give hope to the possibility of improving the lives of the city's citizens but also provide a stark contrast to the official urban resilience agenda in Cambodia.

The paper will start by providing a brief overview of the focus of this paper, Phnom Penh, giving the reader a history of its rise as the mecca of urbanization in the country. The next section will zero in on urban (climate) resilience with a focus on its manifestation in Cambodia, showcasing the perceptions and paradoxes of the narrative. From here, we will cover select examples of individuals/organizations that are contributing to providing an alternative to the high-level resilience agendas and narratives through their work in research and advocacy. We end by discussing how those working within the civil society space are forging activities and strategies, within a culture of repression, that elevates people and politics within urban resilience and in doing so, shine light on the more normative aspects of the resilience agenda.

1 About 18 percent of the population was identified as poor in 2019, with the lowest poverty rates being in Phnom Penh (4.2%) and other urban areas (12.6%), and the highest in rural areas (22.8%) (Sodeth, 2021).

The rise of Phnom Penh as an urbanizing space

During the French colonial period, the urban planning of Phnom Penh followed the model of the colonizers, which meant that the city had big streets and green spaces (Sharda, 2019).[2] The city was again transformed in 1950 when the rulers developed the first masterplan to re-zone areas for industrialization and to build more houses. Yet, the plan was delayed when Cambodia gained independence in 1953. The size of Phnom Penh doubled between 1956 and 1970, which saw a rise in buildings featuring Khmer architecture such as the National Olympic Stadium. This positive development was disrupted by the Khmer Rouge who took power in 1975 and ruled Cambodia until 1979.

When the country transitioned to peace and a new government in 1998, Cambodia started to prioritize urban development from scratch since many of the city's plans and documents had been destroyed during the Khmer Rouge period. During the 2010s, attention to and investment in urban growth from the government and development partners substantially increased (ADB, 2012; World Bank, 2017; WFP, 2019). Phnom Penh enacted a new Land Use Masterplan in 2015[3] and, with support from the Japan International Cooperation Agency (JICA), started to devise an Urban Transport Masterplan. Since then, many initiatives to make the metropolis inclusive and resilient along its development have emerged.

Urbanization in Phnom Penh has been driven by both rapid economic growth and population increase. The city houses three-quarters of the country's industrial investment and a similar proportion of its transportation network (Sharda, 2019). Its population increased from 1.36 million in 2010 to 1.95 million in 2017 (NIS, 2013, 2018) and is projected to double by 2030 (World Bank, 2017). In-migration has been a key driver of population growth in Phnom Penh. According to the 2008 census (NIS, 2009), 28% of the migrant population had engaged in rural-to-urban migration, the bulk of which had migrated to Phnom Penh. It is estimated that rural-urban and urban-urban migrants account for up to 4.1 million people per year, with women outnumbering men (e.g., comprising 57% of migrants to Phnom Penh) (Diepart and Ngin, 2020; Olsen and Vorn, 2020).[4] Although the majority of this migration is short-term, temporary, and circular, the large number shows the importance of Phnom Penh as a destination. Migrants to Phnom Penh are mainly young adults seeking education and employment opportunities (Asif, 2020; NIS, 2012).

As a result of rapid urbanization and development, Phnom Penh has expanded its spatial boundaries to encompass surrounding suburban areas (World Bank, 2017; Thoun, 2021). Mainly, the spatial expansion of Phnom Penh has replaced the natural environment (particularly lakes) with the built environment (especially houses and associated infrastructure) to cater to the housing needs of middle and high classes of the population. Specifically, the urbanizing space has been extended into urban lakes and peri-urban wetlands along river systems, which is a central strategy of developers of gated communities and satellite cities (STT, 2019; Thoun, 2021). This spatial change represents a massive transformation for Phnom Penh: from a city with gravel roads, low buildings, and historical villas with private gardens in the early 1990s to a metropolis filled with skyscrapers and encircled by satellite cities or gated communities (Mund et al., 2020). As of January 2022, Phnom Penh had 61 completed buildings at least 100 m high and 60 more were under construction or approved (Clark, 2022). While evidence for the building boom is obvious, what is less obvious is how many of these buildings will be occupied by tenants (either commercial or residential). Even with some of the buildings already completed, vacancy rates remain low, leading some to conclude that this kind of pattern represents speculation and is not truly sustainable, inclusive urban development (Roughneen, 2016; Nam, 2017b). Meanwhile, the number of gated communities in the city rose from 77 in 2011 to 128 in 2014 (Meng, 2014) and then to 140 in 2021 (Smith, 2021). Here too, however, the reality is that gated communities are for the upper class of Cambodian society since the majority cannot afford the $120,000 to $850,000 price tag of a home (Strangio, 2014b).

This type of urban growth has been at the expense of low income residents living in informal or squatter settlements. By 2011, of 516 urban poor communities in Phnom Penh (Phnom Penh Municipality, 2012), about 30,000 families (or around 150,000 people) were displaced either through planned relocations or forced eviction (STT, 2011; Brickell, 2014). In 2013, at least 36 communities received eviction notices (STT, 2013). The relocation of these communities often occurred with little compensation or support (McGinn, 2015). Relocated sites lacked proper housing, basic utilities and infrastructure, education and health services (STT, 2012), and sanitation (STT, 2016, 2018). Further, residents lost sources of income since the new places offered few economic opportunities, making them return to and resettle in their former area or other informal settlements in the city and thus become vulnerable to new evictions (STT, 2013, 2018). Hence, the urban space for the rising socioeconomic needs of the middle and upper classes has been produced with forceful displacement and deprivation of the urban poor.

2 However, these areas were largely occupied by those within the colonial administration and could not be enjoyed by most Cambodian residents.

3 Since the full details of the Master Plan have never been made public, it remains unclear to what extent it is being used and implemented (e.g., Halim, 2016).

4 This number is an estimate given that a large portion of the temporary migrants do not necessarily appear in official statistics.

Methods

This paper draws on field work conducted in relation to two PhD projects during 2017 (FA) and 2018 (LB). The first was that of the lead author (FA) whose PhD work was connected to the Urban Climate Resilience in Southeast Asia (UCRSEA) project which involved conducting half a dozen interviews with respondents from government and civil society in relation to urban planning and development in the context of climate change vulnerabilities. The second was that of a co-author (LB) whose Ph.D. worked involved 80 interviews with urban poor communities as well as government and civil society stakeholders. Interviews with vulnerable residents explored the risks they face due to environmental changes and urban growth as well as the strategies they employ to improve their own resilience.

We have also included an analysis of secondary research covering a mix of academic literature and media coverage of public protest and other initiatives to re-define urban futures in Phnom Penh. The former involved a literature search *via* Google Scholar using relevant keywords (Phnom Penh AND urban resilience; Phnom Penh AND politics AND urban resilience; Phnom Penh AND urbanization; Phnom Penh AND climate resilience). The latter involved canvassing important English-language media outlets in Cambodia such as *Khmer Times*, *Phnom Penh Post*, *VOD*, *Cambodian Journalists Alliance Association* and others covering affairs in Asia such as *BBC News*, *Nikkei Asia*, and *The Guardian*. In addition, reports from civil society organizations such as LICADHO and Sahmakum Teang Tnaut (STT) provided critical and foundational knowledge gained through their empirical research in Phnom Penh, the urban poor, and impact of urbanization on residents and their vulnerability.

Urban climate resilience in Cambodia: Perceptions and paradoxes

Over the past 20 years, there has been an upswell of rhetoric, programs, projects, and policies related to urban sustainability and cemented into official development narratives through forums such as the UN's New Urban Agenda (UN Habitat, 2016). This rising tide has evolved to include a combination of words: sustainability, smart cities, and resilience (Devuyst et al., 2001; Desouza and Flanery, 2013; Silva et al., 2018; Li and Yi, 2020). Out of this, one term that has gained popularity—both in academic literature and policy initiatives—is 'urban resilience'. The combination of these two terms, urban and resilience, merges two conceptual domains that are equally contested and debated in their meanings and strengths. In particular, resilience has been critiqued as a "vague boundary object" with calls for a more clear, descriptive concept (Brand and Jax, 2007) but also lauded as a "bridging concept" within interdisciplinary research (Beichler et al., 2014; Baggio et al., 2015).

Following this notion, the concept of urban resilience has brought together separate agendas, such as climate change adaptation (Leichenko, 2011; Kim and Lim, 2016; Cobbinah, 2021) and disaster risk reduction (Etinay et al., 2018; Cariolet et al., 2019). Despite this, in the rush to deploy the concept of urban resilience, important questions risk being overlooked: "who benefits from urban resilience?" and "urban resilience for whom, what, when, where, and why? (Meerow and Newell, 2019). In other words, analyzing the politics of resilient cities raises the question: "whose resilience and whose city?" (Vale, 2014).

As outlined by several scholars (Hill and Larner, 2017; Webber et al., 2021), far from being organic, the popularity of urban resilience (among other related terms) has been manufactured, orchestrated, and promoted by a network of organizations ranging from global development institutions (e.g., the UN, the World Bank), private sector actors, and non-profit sector organizations. Moreover, the explicit imbedding of the private sector within urban development planning and its increasingly integral role has resulted in the commodification of urban resilience and the creation of a "neoliberal governance agenda in resilience clothing" (Leitner et al., 2018, p. 1277).

Arguably, one of the countries where this kind of agenda has emerged is Cambodia. Influenced by priorities imported by Western donors, Cambodia has produced multiple written policies related to climate change and resilience, such as the Cambodia Climate Change Strategic Plan (2014–2023) (RGC, 2013) and, at the international level, the Nationally Determined Contribution (NDC) related to the Paris Agreement (Ministry of Environment, 2020). However, Cambodia has historically had a complicated relationship with international aid in the post-Khmer Rouge period. Historically, Western donors have tried to influence policy directions to push for governance reforms while Cambodia officials have sought ways to appear to acquiesce to donor demands without substantially changing any of their actual priorities (Un, 2005). This pattern was evident in the annual donor funding conferences in the post-UNTAC period until Hun Sen ultimately decided to cancel them (Strangio, 2014a). Currently, a resilience agenda has been introduced as a priority for multiple donors including, European bi-lateral agencies and multi-lateral agencies such as the World Bank and Asian Development Bank (ADB). Yet this agenda has also been taken and transformed by national actors who have adopted resilience within policy at the national (e.g., Climate Change Strategic Plan) and, indirectly, at the municipal level (e.g., Phnom Penh).

As with the international actors promoting the "resilience agenda," the way in which resilience is being operationalized in Cambodia, for example, "resilience building" (for climate change) and "urban resilience" (for urban development challenges), has been to focus on institutional capacity building, coordination and investing in infrastructure development

(Bigger and Webber, 2020; Beckwith, 2022). While these are important and worthwhile initiatives, they do not reduce (climate-related) risks for many urban residents because they do not minimize vulnerabilities nor address the poor conditions which unpin vulnerability in poor urban communities (e.g., ineffective waste management exacerbates effects of floods by preventing water from draining efficiently) (Nop and Thornton, 2019). Overall, efforts to build resilience in Cambodia have yet to embrace many of the nuances that have evolved in the academic literature to show how striving for resilience can go beyond "bouncing back" and instead foster transformative change (Pelling and Manuel-Navarrete, 2011; Li et al., 2018; Elmqvist et al., 2019; Normandin et al., 2019).

In Cambodia, there is currently no policy either at the municipal level in Phnom Penh or at the national level that explicitly commits to the pursuit of urban resilience (Beckwith, 2022). Instead, a suite of policies at both levels establish the importance of many aspects of policy development and urban planning in line with a resilience agenda. For example, at the municipal level, Phnom Penh has published the Sustainable City Plan (2018–2030), which aims to support the city's ambitions for economic growth alongside addressing climate risks. The plan presents projects that can, alongside the city's Master Plan, help to achieve environmentally-sound urban growth. Yet, at no point in the Plan is the term urban resilience defined. Such an oversight (whether intentional or not) is emblematic of the incongruence between the stated visions of such high-level policy documents that are ostensibly created to guide urban development on the one hand, and the reality on the ground, on the other hand. Despite formal approval of Phnom Penh's Sustainable City Plan, the lived reality of urban residents and their vulnerability, especially of the urban poor, has not dramatically improved (STT, 2018). The most recent studies of the urban poor in Phnom Penh have shown that not only are urban poor communities *increasing* in number (driven by rural-to-urban migration caused by climate change, indebtedness, and COVID-19) but they also face threats of eviction (STT, 2022). In turn, these factors act as barriers for individuals and households to attain the "safe and quality lifestyle" envisioned by the Sustainable City Plan. At the national level, the Cambodia Climate Change Strategic Plan (2014–2023) identifies climate resilience as a priority but its primary area of interest is rural areas, rather than cities.

Despite these policy commitments, the ways that urban development is happening is not in line with principles typically associated with resilience in the academic and gray literature. For example, urban expansion in Phnom Penh has come at the direct expense of the lakes and wetlands that previously characterized the area. This landscape has been providing crucial ecosystem services by acting both as a natural flood defense and wastewater treatment (APUR, 2019). However, these lakes have gradually been filled in to create new land for urban development. Between 2000 and 2015, an average of 1,000 ha of built up area was added to the city every year, much of it through in-filling (Mialhe et al., 2019). A study by the NGO Sahmakum Teang Tnaut (STT) of 25 lakes and canals in Phnom Penh's inner districts found that by 2015, 15 had been filled completely and 9 had been partially filled (STT, 2015). The impacts of this loss of urban ecosystems are far reaching because the lakes play a critical role in the city's wastewater management, sewage treatment, flood protection and food security (World Bank, 2017). In effect, these decisions and actions by the government have *reduced* the urban resilience of Phnom Penh by eliminating these natural flood defense systems. In their study on how climate-related hazards impact urban livelihoods in Phnom Penh, Nop and Thornton (2019) conclude "our key findings revealed limited local government attention to improving infrastructure and a lack of commitment to assist vulnerable urban poor communities to build resilience to natural shocks." Furthermore, decision-making processes related to urban planning lack transparency with key documents such as the city's complete Master Plan never having been released and details of land transfers to private sector actors shrouded in secrecy (Paling, 2012).

By focusing on so-called "capacity building" and using vague, undefined goals for the capital city in its plans, both discourse and policy related to urban resilience is devoid of political debates, which leaves little opportunity to identify differing inequalities and vulnerabilities. This is due in part to the development of client-patron structures set up over the past decades post-Khmer Rouge that have transformed the political organization of Cambodia to one where satisfying the relationships of patronage supersede meeting the needs of the people (Strangio, 2014a; Eng, 2016). Ultimately, the way in which urban resilience, and the resilience agenda more broadly, manifests in Cambodia in the context of patronage actively undermines any notion of urban resilience that puts people's wellbeing at its center.

This approach results in a "paradox of resilience" where policies that would improve urban resilience are developed, thereby shaping the perception that the government and its partners are "doing something," but the actual decisions made, such as compromising the critical role of the wetland ecosystem surrounding Phnom Penh by infilling the city's largest remaining lakes, undermine long term urban resilience and strategies to reduce vulnerability for people living in the capital (STT, 2019). In the above example, the response by the government has been to deflect instead of engage with criticism of these actions. Prime Minster Hun Sen has alleged that critics of the decision to infill the lakes are simply "jealous" while trying to make the case that they are being hypocritical for singling out Cambodia when other countries (e.g., Singapore) "pump [sand into] the sea" to create land (Sopheap, 2021).

Given this wholesale dismissal of any criticism leveled against the current approach to urban development, it is not surprising that little vocal contestation and disagreement about the depoliticized approach to urban resilience is happening among actors within the country. However, the next section will

outline the ways in which this form of urban development is being contested in subtle, yet differing ways.

Challenging the urban resilience status quo: Examples from civil society

There is a substantial body of literature that has documented the active resistance to land grabs in rural areas in Cambodia, including women's participation (see for example Beban and Work, 2014; Lamb et al., 2017; Park, 2018). However, in contemporary Cambodia, there is less overt resistance to the current model of urban development, even by those directly affected, many of whom prefer to avoid confrontation with the government (Beckwith, 2020). Prime Minister Hun Sen and the Cambodian People's Party (CPP) have secured virtual hegemony by eliminating any political opposition, culminating in the dissolution of the only viable opposition party in November 2017 (Morgenbesser, 2019). This has occurred alongside tight restrictions on civil society organizing and public protest. For example, during the controversial evictions of urban settlements that accompanied the in-filling of Boeung (Lake) Kak in central Phnom Penh, women from the community who stepped forward to lead the protests were repeatedly arrested for their actions (Brickell, 2014, 2020). Moreover, for these women who are evicted from their homes, the destruction of the marital home is a strategy used to deter women from challenging actions by the state (Brickell, 2020). Several local human rights NGOs have also been blacklisted for accusations of collaborating with foreign powers to undermine the government (Sokhean, 2017; Kijewski and Chheng, 2018). The result is a climate of fear and uncertainty which makes many Cambodians reluctant to engage in activities that might draw negative attention (Schoenberger and Beban, 2018). Targeted assassinations of high profile political and environmental activists have silenced much political activism (Wright, 2021).

Despite the crackdown on the various forms of resistance and protestation by individuals and civil society, some groups and organizations are managing to resist the dominant model of urban development and keep the conversation about the future of the city alive. The strategies used by these groups are numerous but in this article, we highlight three main types: 1) small examples of (still heavily repressed) public protest; 2) community-led resilience building and; 3) strategic knowledge creation and the production of publications for research and advocacy.

Public protests: Boeung tamok and mother nature

The decision to begin in-filling Phnom Penh's largest and last remaining lake, Boeung Tamok, has provoked public protest. The dispute began in 2018 when the government announced plans to in-fill a small portion of the lake to be used as a fruit and vegetable market. This decision has been followed by further parcels of land being allocated to Phnom Penh Capital, the Ministry of Rural Development and other government and non-government agencies and private companies, including 300 ha to the Ministry of National Defense to use for the construction of a new Armed Forces General Command (Orm, 2020). Civil society representatives from multiple Phnom Penh-based NGOs have spoken out against the development, citing the risks of flooding if another important wastewater catchment is lost (RFA, 2020). Government spokespersons insist that the impacts on society and the environment are always taken into account but because reports like the legally mandated Environmental Impact Assessments are not publicly published there is little recourse to challenge these decisions.

The example of Boeung Tamok has been regularly mentioned in the local media (e.g., Mech, 2022a; Moeun, 2021) and has caught the attention of environmental activists at Mother Nature, an environmental NGO established by Spanish citizen Alejandro Gonzalez-Davidson alongside two Cambodian co-founders, Thomacheat and Sok Chantra. The organization campaigns to raise awareness of environmental degradation in Cambodia, gaining notoriety for its work on raising awareness of the negative impacts of sand mining in southwest province of Koh Kong. A feature of the organization's campaigns include critiquing and questioning government policies and decisions, resulting in an antagonistic relationship with the Cambodian government (Strangio, 2014a). This kind of relationship has resulted in the targeting and constant harassment by authorities not only of the two Cambodian co-founders but also arrest of the group's volunteer activists (Flynn and Phoung, 2021). Such suppression and persecution eventually led to NGO co-founder Alejandro Gonzalez-Davidson requesting that it be removed from the Interior Ministry's registry of NGOs (Dara and Baliga, 2017; Flynn and Phoung, 2021). At the same time, this has not much impact on the functioning of the group as it continues to function informally as a "movement of concerned citizens," according to Mr. Gonzalez-Davidson (Dara and Baliga, 2017).

In September 2020, three Cambodian activists (Long Kunthea, Phuon Keoreaksmey, and Thon Ratha) were arrested for posting information about a planned protest which would have seen Long Kunthea perform a solo walk to the Prime Minister's house to draw attention to the in-filling of Boeung Tamok (Khy, 2021). The three were imprisoned in May 2021 with charges including "plotting and insulting the King" but have since been released (LICADHO, 2021).

The severity of the response to the planned one-person protest is indicative of how little civil society space exists within which to challenge the current model of urban development in Phnom Penh. Public criticism of the government, even when framed as support for environmental protection, is met with harsh penalties which deters resistance to these practices. This is evident in the case of the Mother Nature activists who carried

the stigma of being dissidents with them even after they were released. For example, Long reported that her prison sentence has led to her family being treated as outcasts from their community as their friends and neighbors fear reprisals just for being associated with her (Flynn and Phoung, 2021). The example above shows how the harsh response to public protest or vocal criticism serves to silence any dissenting voices that might challenge the prevailing practices of urban growth and visions of the urban future of Phnom Penh. At the same time, the example of Boeung Tamok and Mother Nature also shows how there exists a certain level of resilience within members of civil society to engage in activities that draw attention to decisions made by the government despite an overall climate of suppressing actions that so much as resemble dissent or critique. Despite this oppressive context, young activists like Phuon Keoreaksmey embody a kind of boldness, resilience, and conviction in their work, captured in an interview where say says:

> "It's better for Cambodian youths to join us and show they're worried about what the government is doing, yes they can take us back to jail whenever they want, but they can't jail everyone who cares about the environment... We're an example to the youth, we've shown that even a 19-year-old girl can stand up and defend nature from the government." (Flynn and Phoung, 2021)

Through the attention received by actions and young activists such as Keorasmey, Kunthea and Ratha combined with rising levels of education and means of communication, Cambodians across the country are becoming increasingly conscious of the kinds of repression and abuse of power the government is exerting. As such, while the acts of public protests may be quelled by government suppression, the "spirit of resilience" among groups like the young environmental activists, continues to live on. It's important to note here that these public vocalizations contesting government actions and policies are premised on "defending nature," i.e., protecting the environment, which is inherently apolitical. At the same time, the actions by young activists whose zeal rests upon protecting the environment are keeping a space, however small, alive where contestations against the government can be kept alive.

Community-led resilience building: Boeung tompun and boeung cheung Ek

As the space for public protest shrinks, communities in Phnom Penh find other avenues through which to express their visions of an urban future. In southern Phnom Penh, the extensive lake system of Boeung Tompun and Boeung Cheung Ek is at a more advanced stage of in-filling than Boeung Tamok. These lakes and their surrounding wetlands previously absorbed more than 70% of the city's wastewater but have been gradually filled in to make way for the construction of vast gated communities and high end shopping malls (APUR, 2019). The vast wetlands area is surrounded by low income settlements where many families make their living farming morning glory and other aquatic vegetables on the lake's surface (STT, 2020). This urban agriculture was performing an important role in treating the city's wastewater before it returned to local river systems as Phnom Penh lacks a central sewage treatment system (Sovann et al., 2015).[5] As the lakes are filled in, the water circulation is compromised resulting in rapidly deteriorating water quality as the sewage entering untreated from the city is no longer diluted and flushed out and instead builds up, exceeding the capacity of the wetland to treat it and causing pollution and serious health risks for farmers and other local residents, including those downstream. For example, flood waters contaminated with sewage can remain for up to 8 months in certain parts of Phnom Penh, leading to outbreaks of waterborne diseases (Fortnam and Flower, 2015).

Despite the serious repercussions, public protest against the in-filling of these lakes has been minimal. Instead, farmers in the area have been leading their own resilience-making initiatives. In one village on the lake, residents had long wished for a road that would withstand the annual floods which made their homes inaccessible during the rainy season except by boat. In 2017, a local NGO that had been active in supporting the community on housing rights came up with a scheme to link the village to the city year-round. An agreement was reached whereby trucks from the local construction industry would come to deliver dirt and debris that were waste from construction sites to be used to build up the land around the stilted houses. Each household in the village paid $25 USD for this "facilitation fee" and trucks appeared brimming with the rubble of construction sites. Overtime, these truckloads of construction-related waste built up the level of the land around the houses. When the money ran out before the new road could reach the end of the village, the villagers paid again, another $25 USD to ensure access all the way to the end. In addition to support with the coordination of this endeavor, the local NGO put in $2000 USD to cover the road with soil.[6]

5 While there are preliminary plans, submitted to the Phnom Penh City Hall by the Japanese International Cooperation Agency for a wastewater treatment plant to be built, the first stage will only be able to treat 5,000 m^3 of water per day, well shy of the 370,000 m^3 per day of wastewater and rainwater entering the wetlands. Put another way, the wastewater treatment plant will capture only 2% of the total wastewater entering the Tompoun/Cheung Ek wetlands. Meanwhile, funding remains unsecured (the total cost for all four stages is estimated at $1 billion) with no official indication or approval that the citywide wastewater management plan will go ahead (Robertson, 2017).

6 Interview by LB with NGO representative, September 29, 2018.

Though rough and bumpy, not to mention a potential source of pollutants, the trash road was a lifeline for the villagers. While water laps at the edge of the road during the seasonal flood, so far it has remained just above the surface. This makeshift bridge has transformed the fortunes of the village. Homes are now connected to the city all year round, allowing farmers to transport their crops to market without delay and families to send their children to school without fear. The road has even opened up a new livelihood opportunity for some, who scour the debris for bits of metal and other valuable waste. The road is an example of the collective resourcefulness of the community. Pooling their finances and with the organizational support of a local NGO, the construction of the road shows the benefit not only of access to resources but the will to envision a future for their community and bring it into being collectively. This is a promising indicator of the potential for resilience building within the community, given that the ability to leverage social capital in order to act collectively is fundamental to building adaptive and transformative capacity (Elmqvist et al., 2019).

In addition to its functional role, the road is intended to fulfill a symbolic role, supporting the claims that the villagers have to the land that they occupy by showing their willingness to invest in the development of their community. By building communal infrastructure, the villagers can argue that they are not squatters on public land but custodians who are taking responsibility for their village. In this case, the efforts of community members and their supporters to kickstart local resilience building has been successful with the government following through on their promise to grant hard land title to residents with appropriate documentation as well as paving the road and installing drainage for the community.[7]

This example of a community taking matters into their own hands to improve urban infrastructure also highlights how an erosion of trust between urban communities, like the one's that surround Boeung Tompun and Boeung Cheung Ek lakes, and authorities has evolved over time, catalyzed by a history of evictions in urban poor settlements (see McGinn, 2015). To be sure, the example of Boeung Tompun and Boeung Cheung Ek and the threat of eviction of people who live in its surroundings is not new. As Connell and Grimsditch (2016) outline in their coverage of forced relocation in Cambodia, 20,000 people living in the Boeung Kak Lake area in Phnom Penh were displaced as developers began filling the lake and residents were flooded out of their homes. While this case was made more complex due to the interaction between a multi-donor land-titling program financed by the World Bank program and a 99-year lease granted to a private developer, the role of civil society organizations was critical in using established complaints structures to advocate for greater accountability. Similarly, in the above example of Boeung Tompun and Boeung Cheung Ek, the organizational support provided by the local NGO to residents of the area proved instrumental. However, a critical difference is that due to shrinking civil society space and lack of formal complaint mechanisms, much of the work is being done with less vocal/formal contestation and protest toward the government. Instead, community-led urban development, driven by creative action (i.e., using construction refuse to build a road) and pooling of resources has increased the legitimacy of the community and claims to their right to remain on the land.

As of July 2022, about 80 families living around Choeung Ek commune are still waiting land titles that were promised to them in 2020 by the Land Ministry. One such resident who is now fearful of being evicted from the land she has lived on since 1982 is Chek Soknai. She lives on a plot of approximately 6 meters where she, like others in the community, grow vegetables and catch fish in the waters that surround their village (others work in construction or as factory workers). In speaking about her situation, she says "When we have our land title we will feel comfortable about living. But when we don't have one, we fear living there. We fear forced evictions, losing our livelihoods. In this place we have everything to make a living" (Sokun, 2022).

Therefore, while it remains to be seen when, and whether, all of the households are able to obtain hard land titles, the example of some communities within the Boeung Tompun and Boeung Cheung Ek area highlights how some marginalized urban communities are attempting to be resilient and claim their space despite living in a city whose machinations of urbanization have led to exclusion and involuntary settlement "as a radicalized mode of urban production rooted deeply in the urban history of the city and sustained by the legal apparatus" (Astolfo, 2021, p. 220).

Strategic knowledge creation: Sahmakum Teang Tnaut

Increasing knowledge and awareness on aspects of urban climate resilience (e.g., disaster management and preparedness, flood response and prevention, etc.) is especially important for urban residents. This point is underscored by findings of a recent study by Khan (2019) on urban flooding in Phnom Penh which found that residents of Phnom Penh receive little information on disaster preparation/management and health measures to employ during flooding. Moreover, from the 300 respondents surveyed across three *sangkats* in Toul Kork, the study found that citizens of the city did not perceive the intensity of flooding to be caused by the loss of urban wetlands. Such a lack of knowledge of the relationships between changes to the physical environment and flooding underlines the important role that knowledge creation and dissemination play in mobilizing citizens to hold decision makers accountable. Within Phnom Penh, one group that is helping to fill this role is civil society organizations.

In addition to supporting community-led resilience building, civil society organizations in Phnom Penh have

7 Interview by LB with local residents, March 27, 2022.

also kept open a dialogue on alternative approaches to urban planning and expansion through the production and publication of research reports on various aspects of Phnom Penh's development. Notably, local housing rights NGO Sahmakum Teang Tnaut (STT) has published an array of research about urban issues such as informal settlements, access to public space and the aforementioned report on the in-filling of the city's lakes and wetlands. These reports have typically been published in both Khmer and English and are available for free online. The reason we call this "strategic" is that these types of knowledge creation activities allows the organization to continue to engage with low income communities, staying aware of, and promoting, their needs without directly challenging government bodies in a way that would put their organization or staff members at risk of reprisals. By focusing on the core issues that directly negatively impact urban residents (instead of criticizing the government per say) and increase their vulnerability to losing land tenure rights (including eviction), flooding, health impacts from pollution, among other consequences, STT keep the focus on the need to for government action to ameliorate these issues and respond to the needs of residents. Instead of activism or advocacy, the information garnered from community engagement and qualitative/quantitative research is presented in a more neutral tone which aims to inform rather than provoke.

This is noticeable in the recent report from a collection of human rights NGOs about the implications of the in-filling of Boeung Tompun and the surrounding area. The report, *Smoke on the Water: A social and human rights impact assessment of the destruction of the Tompoun/Cheung Ek Wetlands* was produced by STT, Equitable Cambodia, LICADHO, and the Cambodia Youth Network and aims to shed light on the negative impacts of the way the area is being developed. Importantly, the report keeps silent on the political connections of the people who were given ownership of the land presumably to avoid engaging in allegations of corruption that would provoke a response from the government. While response to the report was subdued in Cambodia, it was picked up and highlighted in the foreign press (Handley, 2020; Knaus, 2020). It is noteworthy that although many of the environmental impacts of in-filling are mentioned in the report, they are not taken as priority issues on their own but rather seen through the lens of their impact on people.

The clear avoidance by STT as an NGO in pointing blame or criticism directly at the government is intentional and for good reason given how the government has in the past blacklisted NGOs by accusing them for inciting a "color revolution" as a means of overthrowing the government—a charge often touted by government officials (Sokhorn, 2019; Sony and Keeton-Olsen, 2021). However, a recent government press conference may be a glimpse of change from such adversarial sentiments toward civil society. On June 29, 2022; the Justice Ministry held a press conference which included invitations to, and attendance by, human rights NGOs Adhoc and LICADHO[8] with the aim of starting a "culture of dialogue" according to a government spokesman (Mech, 2022b). In his remarks discussing the new press conference format, Justice Ministry spokesman Malin said "And this [press conference] is the start of a culture of dialogue between the civil society and spokespersons of the government. It is good that we sit and talk with each other and exchange views." (Ibid). Such an explicit statement of open dialogue and consultation with members of civil society by a government official offers a glimmer of hope to not only more inclusive urban development policies but also validates the effort and approach of strategic knowledge creation by civil society organizations like STT.

Discussion

Scholars have pointed out how the evolution of the relationship between people and politics has been enacted in a systematic and particular way by the Cambodia government (e.g., dissolution of opposition party) (Un, 2005; Hughes and Eng, 2019; Morgenbesser, 2019). This approach has ushered in an climate of suppression of civil society and collective action, including environmental activists and activities raising the voices of the urban and rural poor (Schoenberger and Beban, 2018; Beban et al., 2019). Almost in parallel and in a complementary fashion, the nature of urbanization has been transformed in the image of this contemporary political landscape. For example, the in-filling of Boeung Tamok lake to make way for a fruit and vegetable markets under the guise of "beautification"[9] is, in reality, a trojan horse for gentrification which represents a transformation and remaking of class within the urban landscape (Lees, 2012)—a process associated with the Global North (Smith, 1996). However, unlike how the process has unfolded in the Global North,[10] the way it is occurring in Cambodia (and other parts of Southeast Asia) is different insofar as the leaders of urban (re)development are largely state-backed/state-affiliated private actors producing megaprojects (e.g., gated communities) for the elite. In that vein, the question arises: who is the city built for and whose lives and whose freedoms are being negatively impacted?

8 The Cambodian Center for Human Rights (CCHR) and Sahmakum Teang Tnaut (STT) were absent from the meeting. According to CCHR director Chak Sopheap, she received an outdated invitation (Mech, 2022b).

9 For example, Vision 1 of the Phnom Penh City Development Strategy 2005–2015 states "Phnom Penh is a city with [...] well managed and splendid beauty" (STT, 2012).

10 It's important here to note that we do not imply that the process 'originates' in the Global North and is 'imported' to the Global South. Rather, as Lees (2012) argues, gentrification is multi-centered and has likely existed for decades in (South)east Asia.

An illustrative case looking at the social consequences of urbanization in Phnom Penh can be seen from the work of Brickell et al. (2018) who connect climate change impacts felt by rural households to the brick kilns outside of Phnom Penh. The authors reveal how crop losses, exacerbated by climate change, have driven families into increasing debt which, in turn, has forced families to migrate from their village to find wage labor. For some, this means they end up at these brick kilns. Once there, families (including children) end up being trapped in debt bondage with slim chances of escaping such a fate. On top of this, the actual process of brick making produces noxious fumes and contributes to local air pollution through the burning of pre-consumer garment waste. Taken together, their work highlights the interconnections between climate change, people's vulnerabilities, modern slavery, and urbanization. Similar to the case of migrant families trapped in bonded labor across the brick kiln sites outside Phnom Penh, the lives and freedoms of the urban poor are also negatively impacted by wider processes of climate change and its consequences (e.g., flooding) which compel some to migrate elsewhere, often to areas that are highly vulnerable to climate change-related impacts, i.e., low-land areas (Astolfo, 2021). Often these sites are far from places of their employment which increases both costs (e.g., transportation) and livelihood precarity (Fortnam and Flower, 2015). Moreover, the fundamental process of urbanization involves large amounts of energy. In Cambodia, over 50% of total energy use is provided by fossil fuels (coal, oil, natural gas) (IEA, 2022). In the case of coal-fired power plants, not only do they contribute to increased carbon emissions but also exacerbate local air pollution—much like the brick kilns of Phnom Penh. As a fundamental and literal building block in urbanization, concrete is an essential component, but, at the same time, its production has significant carbon emissions (Barcelo et al., 2014). In this context, the form of urbanization taking place in Phnom Penh becomes paradoxical to the notion of urban climate resilience and stands in strong contrast to the dominant narrative that is part of the resilience agenda in the country. Collectively, the way urbanization is occurring in Phnom Penh, and being sanctioned by state and private interests, is undermining efforts toward true urban climate resilience and instead, is negatively impacting urban poor people's lives and freedoms.

Despite this, our three examples (public protest, community-led resilience building, and strategic knowledge creation) highlight the varying ways people and organizations are challenging the prevailing model of urban development and how activism and advocacy related to urbanization and the needs of urban citizens has shifted partly in response to this socio-political context. In doing so, we show how people, communities, and civil society have evolved and adapted the way in which they challenge the status quo and unilateral policies/actions by the government. The tactics used by organizations like STT echo what Lawreniuk (2021) observes in the case of the iconic "White Building" in Phnom Penh and its (and the community therein) struggle for survival where "covert opposition counters repression of overt contestation" (p. 647). Most importantly, the three examples show that alternative perspectives and challenges to the status quo on urban development have not disappeared entirely but have changed form through the use of alternative, nonsubversive tactics that are able to operate within an environment that supresses dissenting voices.

Some of these tactics are part of an broader movement such as the example of community-led resilience that we highlighted. This kind of response by residents within Phnom Penh is certainly not an exception, rather, it is part of an increasing trend of communities using collective action to protect the areas they live from urban disaster risks. For example, in their report on vulnerability of the urban poor in Cambodia to flooding and other hazards, Fortnam and Flower (2015) highlight various community-level adaptations among residents of Phnom Penh involving locally-engineered solutions. In the Sangkat of Chamrouen, for instance, the community has constructed a dyke to protect the community against river flash floods, and in 2014 the Sangkat authorities—in partnership with local NGOs and the community—raised the height of the road by 1.4 m to have the area be more resilient to floods. At the household level, residents have managed to make adaptations to their homes such as constructing stilts to raise their house above the floodwaters and build concrete foundations. For many households, these kind of local-level resilience-building strategies have been enabled by loans from microfinance institutions (MFIs). Although these loans have been critical in providing cash during moments of acute need such as during the rainy season and have increased household-level resilience, they come at a cost of exacerbating household debt. In the long-term, as the pressure of debt repayment squeezes household's finances, this strategy may hinder future coping and adaptation and potentially increase their vulnerability (Fortnam and Flower, 2015).

The example above, and the others highlighted in this article, bring to the surface the politics of resilient cities (and urban resilience in general): in practice, cities are developed and organized in a way that (re)produces and reflects socio-economic inequalities. Environmental impacts are experienced differently across a city, depending on multiple factors including socio-economic vulnerability, which often correlates with the spaces within a city that are physically and environmentally vulnerable. The work of STT in particular has highlighted this correlation with respect to the urban poor and their (in)ability to respond and adapt to changes in their environment (STT, 2012, 2018). This opens up the likelihood of creating "uneven resilience" (Vale, 2014) whereby certain areas of the city are more resilient to environmental impacts (e.g., flooding) than others. As Vale (2014) elaborates: "uneven resilience threatens the ability of cities as a whole to function economically, socially

and politically. Resilience can only remain useful as a concept and as progressive practice if it is explicitly associated with the need to improve the life prospects of disadvantaged groups" (p. 191). In certain cases, such as the infilling of the lakes around Phnom Penh, the consequences are felt across socio-economic groups with both poor and wealthy neighborhoods impacted by flooding. The crucial difference between these two groups, however, is their ability to draw upon resources (social ties, capital, labor) to respond, adapt, and cope with these impacts. For example, the ability to stay home and work in the case of an office job, driving large SUVs that are able to navigate flood waters, and living higher up (i.e., above street level). Geography plays an important role too. Wealthy households not only live higher up but many are also located in areas of the city that may be less prone to flood risk (e.g., due to better supporting infrastructure such as drainage), compared to, peri-urban areas where a high concentration of the urban poor live, and where land use change has been the most rapid. As a result, these peri-urban areas are where development-induced flooding is the most severe (Fortnam and Flower, 2015).

The examples also show the contrast between the orthodoxy of urban development in Phnom Penh and the way in which others within civil society view how urban resilience "should be" realized through their actions, not only from a climate or socio-economic perspective but also in terms of a social justice and political perspective. This involves asking questions such as *who* is this kind of urbanization for? *Who* is involved in making *decisions*? *Who* does it *include*? *Who* does it *exclude*? Asking these kinds of questions in the context of urban (climate) resilience adds an important, though oft-overlooked, dimension in conversations around urbanization processes and climate change impacts in cities like Phnom Penh. For cities to become resilient to risks faced by climate change-related impacts, they need to accumulate the social, political, financial, and institutional structures in a way that supports addressing these risks (Satterthwaite, 2013). Given the current socio-political climate in Cambodia and the dominance of a top-down resilience agenda, we believe that such developments are most likely to happen through community-led resilience building efforts. Alternatively, they can occur with cooperation between government, civil society, and urban communities. As our examples show, efforts by individuals and organizations that represent the marginalized voices are of paramount importance in efforts to achieve urban resilience that takes into account the rights of all urban residents. While the likelihood of this occurring in Phnom Penh is difficult to predict, at the very least, our examples show that there is still an active and strategic effort by actors within civil society to keep such a space "alive" and present. Indeed, such "bottom up" push from urban citizens and civil society on both city and national governments will be important to reduce urban vulnerabilities from climate change-related risks and support well-being of all urban residents, regardless of socioeconomic class, wealth, and status.

Conclusion

The actions taken by the actors highlighted in this article are (indirectly) responding to, and contesting, the answer to the question posed by Meerow and Newell (2019) of "resilience for whom?" and Vale (2014) question "resilience for whom and against what?." Specifically, whose vision of a resilient future counts, and ultimately, prevails. Likewise, who benefits and who loses as a consequence of the policies and actions adopted? Addressing these questions collectively, this paper draws upon three examples to show that even if the urban environment is not being designed to be resilient—the urban citizens and civil society certainly are by protesting against resilience-reducing policies, collectively organizing for resilience-building activities, and engaging in strategic knowledge creation and dissemination.

In Phnom Penh, it is clear that the city is following a path of privatized urbanization wherein the private sector and actors therein have significant influence and power in shaping the future of the urban space (Percival, 2016). Yet, despite this overarching context, the examples we have highlighted show how communities are using collective action to advocate for their versions of urban resilience and the different approaches taken to showcase their critique and resistance. The initiatives such as those by STT center on conveying of information in a more neutral way, but importantly focusing on the impact on everyday Cambodians instead of weaving in politics and "pointing fingers," shows promise as a new way of engaging and contesting the status quo of urban development in Phnom Penh. The kind of resilience shown by urban citizens (a large portion of which are among the urban poor) should be reflected within the policy and programs of urban planning in Phnom Penh if policymakers and the leaders of the city/country want a capital that is well-adapted, sustainable, liveable, and prosperous in the twenty-first century.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

FA and LB led the core development and framing of the article with support from CN. FA led the writing of the manuscript with LB contributing to the case studies and CN

to the Phnom Penh section. All authors contributed equally to revising the full manuscript.

Funding

FA and LB was supported by Canada's Social Science and Humanities Research Council (SSHRC) and the SSHRC-funded Urban Climate Resilience in Southeast Asia (UCRSEA) Project.

Acknowledgments

The primary research used within this article of the first two co-authors (FA and LB) was supported by Canada's Social Science and Humanities Research Council (SSHRC) and the SSHRC-funded Urban Climate Resilience in Southeast Asia (UCRSEA) project. The authors would also like to graciously thank the two reviewers of this manuscript whose valuable and constructive comments greatly improved the quality of the paper.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Sustainable Cities

TYPE Original Research
PUBLISHED 18 April 2023
DOI 10.3389/frsc.2023.929121

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to
Climate Change and Cities,
a section of the journal
Frontiers in Sustainable Cities

RECEIVED 26 April 2022
ACCEPTED 22 March 2023
PUBLISHED 18 April 2023

CITATION
Ekoh SS and Teron L (2023) Vulnerable spaces,
unequal responses: lessons for transformative
climate resilience in Lagos.
Front. Sustain. Cities 5:929121.
doi: 10.3389/frsc.2023.929121

Vulnerable spaces, unequal responses: lessons for transformative climate resilience in Lagos

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Urban coastal megacities like Lagos face flooding challenges that may be exacerbated by climate change in the future. Through an urban political ecology lens, this study engages with the dynamics of politics and power that produce differentiated flood impacts and adaptation strategies. Data from telephone interviews of 21 Lagos residents across the mainland and island areas reveal people's understanding of their flood vulnerabilities within the wider socio-political context of Lagos. In particular, state failure in the provisioning of services, amenities, and overall flood protection, shapes flood risk in Lagos. In addition, income and access to material resources inform people's experiences and ability to cope with flooding. Furthermore, citizens apply localized strategies to prepare for and cope with flooding events, particularly through Community Development Associations (CDAs). These localized strategies have implications for transformative resilience. However, these forms of endogenous resilience cannot replace attention to wider urban governance challenges in cities like Lagos.

KEYWORDS

urban political ecology, coastal cities, coastal flooding, community-based adaptation, climate change vulnerability

Introduction

Lagos, Nigeria, along with coastal cities globally, will be presented with flooding and sea level rise imposed threats as a result of climate change (Schraven et al., 2019; Rigaud et al., 2021). Lagos is a megacity with a population of 21 million people, off the Atlantic Ocean in West Africa. Its low lying elevation (~15 m above sea level) influences the city's biophysical vulnerability to sea level rise and coastal flooding [Lagos State Government (LASG), 2013; Heinrich Boell Stiftung, 2018]. Past flooding events (i.e., 2012, 2020 floods) have led to displacement and loss of lives and property (Ajibade et al., 2013; Soneye, 2014; Hansen, 2021). Cost of damages associated with flooding in 2011 reveal an estimate of up to US $200 million (FSD Africa, 2021). Estimates show that the flooding of 2012 led to upwards of 2 million residents being displaced (Atufu and Holt, 2018). While Ologunorisa et al. (2022) estimate that around 50 people have lost their lives from 1985 to 2017 in Lagos due to flooding events.

Along with its coastal geography, Lagos is also surrounded by lagoons, wetlands and creeks which contribute to river flooding, which is exacerbated by urban sprawl and unregulated development (Heinrich Boell Stiftung, 2018). Urban planning issues and state inefficiencies at flood management also contribute to flooding in Lagos (Adeloye and Rustum, 2011; Kasim et al., 2021). Historically and into the present, urban development in

Lagos has involved the transformation of biophysically vulnerable spaces to accommodate rapid urbanization (Bigon, 2016; Kasim et al., 2021). For example, housing structures are built on sand-filled swampy terrains, predisposing residents in those locations to the effects of flooding (Aluko, 2010). Vulnerability for inhabitants of informal settlements in amplified as residents must engage in adaptation with limited resources (Adegun, 2022). Generally, trust in government among Lagos residents to support flood risk reduction is low (Ekoh et al., 2022). Therefore, transformative resilience is necessary to ensure that the most vulnerable are sheltered from the impacts of climate change. Transformative resilience goes beyond simply climate-proofing existing infrastructures or development patterns and instead calls for scholars, activists, policy-makers, and practitioners to "identify root causes of vulnerability and barriers to resilience, and actively challenge the institutions, vested interests and power relations that create these conditions" (Bahadur and Tanner, 2014, p. 211). To understand these root causes and the possibilities for transformative resilience, it is imperative to engage with the production and distribution of flood risk in Lagos, and flood responses.

In acknowledgment of the above, this paper adopts an urban political ecology approach to understand people's experiences of flooding within the wider socio-political context of Lagos flooding and the possibilities for transformative resilience in the city. An urban political ecology approach considers the influence of politics and power that shape environmental outcomes in urban areas (Swyngedouw and Heynen, 2003; Lawhon et al., 2014; Coates and Nygren, 2020). In particular, this paper considers the importance of state urban development policies and discourses in shaping flood risks and responses. It asks: (1) how are flood vulnerabilities and responses differentiated among Lagos residents?, (2) What role does the state play in these outcomes? and finally, (3) What are the implications for adaptation responses? This study sheds new insights on the perceived role of the state and state policy in the Lagos context in shaping flood vulnerabilities. The paper also documents promising "endogenous" sources of transformative resilience in the work of Community Development Associations. Whereby endogenous resilience is one that is developed and driven from local contexts and by local people vs. top-down efforts (Ziervogel et al., 2017).

Literature review

Vulnerability

Adger (2006, p. 269) defines vulnerability as "a state of susceptibility to harm." Interpreted as the conditions that make people able or unable to cope with harm. This definition is often further disaggregated into exposure, sensitivity, and adaptive capacity. *Social vulnerability* on the other hand, helps with understanding the social dynamics of people's susceptibility to harm and their ability to cope with effects of events such as disasters (Singh et al., 2014). Risks from disasters caused by climate change events affect a wide variety of people regardless of socio-economic factors (Allen, 2003; Wisner et al., 2004). However, the level of impact or ability of people to respond and recover from these events—or their adaptive capacity— is influenced by socio-economic factors (Wisner et al., 2004) and wider societal structures inequality (Bullard and Wright, 2009). For example, Ajibade et al. (2013), in a study of coastal Lagos residents, find that low-income women experienced the most impacts of any group.

Income is a social vulnerability factor, whereby less economically powerful groups are more likely to reside in the most hazardous areas where land costs are lowest (Marks, 2015). Lagos is unique because high-income neighborhoods like Lekki and Victoria Island encounter flooding similar to lower income neighborhoods such as Ikorodu.[1] Mehrotra et al.'s (2009) case study of Lagos echoes this point by revealing that that even though slum settlements in Lagos are biophysically vulnerable, affluent neighborhoods equally experience biophysical vulnerability, especially places like Ikoyi which are 60% wetlands.

Urban political ecology and flood risk in Lagos

Vulnerabilities do not exist in isolation; they emerge from demographic, political, and economic processes; hence, the distribution of power and material resources in a society matters (Blaikie et al., 2005). Examining practices of the state government in Lagos offers insights to the production of vulnerable landscapes that expose Lagos residents to differing levels of flood risk and shape their capacities to respond. Of critical importance is the state government's approach to urban development. In September 2013, the Lagos State Government (LASG) enacted a development plan with targets set for 2025, by the administration of the then state governor, Babatunde Raji Fashola. The plan comprises of four pillars of development, namely economic, infrastructure, social development and security, and sustainable environment [(Lagos State Government (LASG), 2013)]. Its vision for the future of Lagos is articulated as making Lagos "Africa's model megacity and global economic and financial hub that is safe, functional and productive" [(Lagos State Government (LASG), 2013)]. Within the plan, the LASG recognizes flooding as a major issue that requires attention. It also presents strategies for addressing challenges that include effective flood warning systems, structural interventions, and wetlands management [Lagos State Government (LASG), 2013; Heinrich Boell Stiftung, 2018]. However, in practice, efforts to achieve Lagos's development plans are questionable given the limited access to basic amenities, the dearth of affordable housing, and poor sanitation conditions that people in the city are faced with (Abubakar et al., 2020; Dano et al., 2020; Shiru et al., 2020). In

1 The areas of Lagos are majorly categorized into two—the island and mainland, which this study adopts in the analysis. Physically, the island areas refer to locations beyond the 3rd mainland bridge, which is a bridge measuring 7.3 miles, that separates the mainland suburbs like Ikeja, Ikorodu and others, from areas around the coast, such as the ancient *Isale Eko* (Lagos Island), Lekki, Victoria Garden City, and Ajah. Areas on the island are largely associated with middle-and high-income earners. Although, informal housing structures occupied by lower income groups can be found in these areas especially around the creek.

2020, widespread youth protests known as ENDSARS[2] drew public attention to these issues.

There is some progress toward Lagos's economic development plans, though the pace and focus of projects are subject to debate. Some of these economic development activities have been carried out without proper attention to social and environmental impacts or considerations (Lawanson and Agunbiade, 2018). Urban redevelopment projects are concentrated in parts where colonial administrators, economic and political elites lived during colonial times (Bigon, 2008; Elias and Omojola, 2015). An example of the LASG's debated approach to development can be seen in Lawanson and Agunbiade's (2018) analysis of Lekki Free Trade Zone project. Although aimed at economic development and to attract foreign direct investment, outcomes showed that Indigenous communities were displaced and not duly compensated according to the terms of agreement on land use (Lawanson and Agunbiade, 2018). Other elite-focused economic development plans like the Eko Atlantic City project have displaced low-income groups and appropriated and enclosed the beach front areas, leaving the poor more physically and socio-economically vulnerable (Ajibade, 2017). These are important examples when flood vulnerabilities are concerned because the displacement of the urban poor, without benefitting from the proposed developments, can push people into vulnerable housing conditions and decrease their ability to cope with floods (Ajibade and McBean, 2014). Furthermore, even though the State has agencies responsible for flood preparedness and management in Lagos, literature suggests that these have been unsuccessful for various reasons, including bureaucratic processes and lack of cross-agency coordination (Heinrich Boell Stiftung, 2018). In some instances, structural interventions to curb flooding by the government have displaced low-income communities, for example, the LASG's "Great Wall of Lagos" project (Adelekan, 2016).

Lawanson and Agunbiade (2018) and Olajide and Lawanson (2021) echo the sentiment, asserting that the LASG has adopted a neoliberal approach to development whereby the economy is prioritized over social and environmental factors. The LASG has embarked on urban (re)development projects connected to the global market through international funding from financial institutions, aimed at attracting foreign investments (Olajide and Lawanson, 2021). Chinese contractors are among private sector developers brought in to implement the (re)development projects (Olajide and Lawanson, 2021). However, studies suggest that low-income residents of Lagos are often the most affected by these projects, through displacements (Lawanson and Agunbiade, 2018). Weak housing rights form the backbone of marginalization for these vulnerable groups (Ajibade and McBean, 2014). Past literature suggests that biophysical vulnerable spaces and poor environmental management practices (see: Blaikie and Brookfield, 1987) predispose people in these areas to the adverse effects of flooding (Ajibade and McBean, 2014).

Yet, there is a need for understanding how recent efforts, such as the 2013 plan, have served to alter risk exposure and responses. Moreover, there is room to recognize how people exercise agency within these constraints, given calls for transformative resilience scholars to understand endogenous forms of resilience (Ziervogel et al., 2017).

Materials and methods

Data collection and analysis

To answer the above questions, this study employed semi-structured interviews with residents of Lagos. Interviewees were sampled purposively from a wider PhD dissertation study (Ekoh, 2021) that involved online surveys (352 completed), where respondents indicated interest in a follow up interview. Respondents who indicated interest in participating in a follow up interview from the surveyed sample were redirected to a separate form to gather necessary information for further contact. A total number of 21 interviews were scheduled. We completed Internal Review Board (IRB) approval processes required for this study. IRB number is 20-061. Electronic consent forms were presented to participants prior to the interviews, where participants were provided with information on the study and had the liberty to make a choice to proceed with the interview or to decline.

Recruited participants reside in the island and mainland areas of Lagos. About 76% of interviewees are mainland residents while the rest live on the island areas. Participants comprised of 7 people who identify as female and 14 who identify as male. Although attempts were made to have greater gender-balanced representation within the survey, lack of response from potential participants posed constraints. The age range of interview participants was between 25 and 45 years old. About 80% of participants had directly experienced flooding in the past 10 years. For those that lacked direct flood experience, some of them shared indirect experiences or observations of flood events. Pseudonyms are used in this paper to protect the anonymity of participants. The first author conducted the interviews with participants from August 2020 to September 2020.

In this study, we take a reflexive thematic approach to analyzing the qualitative data (Braun and Clarke, 2021). According to Braun and Clarke (2021), reflexive thematic analysis may involve a six-step process, although these steps are prescriptions and can be flexible (see Braun and Clarke, 2021). Braun and Clarke (2021) emphasize the need to recognize and highlight underlying theoretical assumptions. We adopt this approach to the data analysis for this study.

In this regard, the coding development was iterative, involving two cycles coding. Codes were refined accordingly throughout this process. Themes were generated from the data across central elements that unified aspects of the data. Likewise, visual tools on NVIVO software also offered an avenue to see patterns across experiences shared by participants, aiding the establishment of themes.

Furthermore, reflexivity included reflecting over emerging themes from the data, and especially patterns that challenged prior knowledge of the context of flood vulnerabilities in Lagos.

2 ENDSARS protests occurred nationally but Lagos was a key location for protests. The primary reason for the protests were youth resistance to police brutality. However, the protests evolved to cover issues of poor governance.

This stemmed from the first authors positionality as a former resident of Lagos, including prior awareness of flood issues in Lagos. In presenting results, we take a constructivist theoretical approach (Crotty, 2020) where we are interested not only in what people are saying but how they describe experiences and events; we reflect this in the interview excerpts that are highlighted.

We embed the entire study in an urban political ecology approach, as we attempt to understand flood vulnerabilities among Lagos residents. This means that in our data analysis we paid close attention to dimensions of power and politics at play in flood experiences and responses shared by respondents in this study. We build on other studies in the literature that have applied urban political ecology to flooding using qualitative analytical approaches (e.g., Marks, 2015; Ajibade, 2017; Abass, 2022).

One (perceived) limitation of the study is the ultimate number of interview participants. Initially, the project called for the lead author to conduct on the ground interviews and community focus groups in Lagos in the spring of 2020. This period ultimately coincided with the early stages of the COVID-19 pandemic and that approach was no longer feasible for public health purposes nor allowable due to travel restrictions. Online surveys and remote follow-up interviews offered an alternative strategy, which may have limited the number of possible respondents for the study. Notwithstanding the adjustment in approaches to conducting interviews, the intricate nature of what was captured is substantial; several interviews lasted nearly an hour and revealed participants' deep understanding of, and experiences with, threats associated with flooding. The interviews progressed to the point of data saturation, which in qualitative methods implies that no new themes were unfolding (Doolittle, 2015).

In addition, in some cases interviewees would share their observation or analysis of events and not always their own direct experiences. However, it still offers beneficial insights to how vulnerabilities to flooding might manifest in the area and similar contexts, and the in-depth and semi-structured format of the interviews allowed for a valuable window into residents' perceptions of risk and the factors motivating their responses.

Results

This section presents results from interviews for this study and offers two key insights. Firstly, respondents understand their flood vulnerabilities across the lines of income, housing conditions, land tenure and the unregulated activities of landowners. Reflecting the wider socio-political context, e.g., influences of state policies and (in) actions on flood vulnerabilities as well as individual capabilities with respect to material resources that affect the ability to cope with flooding events. Secondly, in response to flooding, residents apply localized efforts to cope with current or anticipated flood events. Specifically, an interesting aspect of flood response by Lagos residents and a key source of "endogenous resilience" (Ziervogel et al., 2017) is the role of community development associations (CDAs).

Understandings of flood vulnerabilities: the urban poor and "elite"

> *"We have swampy areas for [the] common man and we have swampy areas for the rich too… Like Ajah, the Lekki environment… They are vulnerable to floods!... So, they also will be involved in it. And we have the swampy area that belongs to the poor people that will also be vulnerable."*
> *(Ife, Phone interview, August 29, 2020).*

The above is an excerpt from an interview with Ife, a Lagos resident. It shows the widespread understanding that all residents of Lagos face some flood risk, regardless of income levels. Although, further insights show that income is a significant factor in the ways that people experience flooding in Lagos. The presence and quality of amenities and infrastructure in Lagos neighborhoods determine how impactful flooding will be. Underdeveloped areas lack amenities and infrastructure that leads to worse flood experiences. *Ima*, an interview respondent spoke on how certain neighborhoods such as "Lagos Island, Lekki, or Ikoyi… are generally cleaner and have better houses." Interviews also suggest that the government tends to establish urban development projects in areas where the wealthy live first, attending to poor people last and usually after much persuasion. Interestingly, urban projects concentrated in high-income areas of Lagos are problematic because these areas are biophysically vulnerable to flooding.

For example, *Kunle*, an interview participant said:

> *"The need for housing, the need for road, the need for bridges, has pushed [the] government and people to go into areas that they are not supposed to go into areas that should serve as… so to say… sinks… wetlands."*
> *(Kunle, Phone interview, September 12, 2020).*

The statement above reveals how the natural environment in Lagos, especially physically vulnerable locations such as wetlands, littoral zones, and other low-lying areas have been transformed. The concentration of urban development projects on the island areas—made up of Lagos Island and other neighborhoods, including places like Lekki and Ikoyi—contribute to a class-based attraction to these places for people looking for where to live, even though parts of these areas are prone to floods. The new government and private development project—Eko Atlantic City in this area of Lagos is driving encroachment into low lying flood prone areas. *Ini*, a resident of Lekki articulates this point by saying:

> *"Lagosians, we try to… you know… anyone that makes some good money, if he doesn't live in Lekki, then he's not rich! Why? Because, over the years, Lekki has been made to be a small Dubai or a small London—reserved region, because the government has invested in security, invested in the topography of the land, invested in beautification of the place, and so it's believed that a certain elite group are to be found there! So, anybody that has some good change believes; "if I'm not in Lekki, then I'm nowhere." So, on the part of the citizens, they've bought into the lie, and created their own lie in a way that made it look so real. So, two lies suddenly became one truth! From the part*

> *of the government and the part of the individual. So, everybody now moved there because it was a small Eldorado. But, they forgot that in the midst of the Eldorado that there was something that was not permanent, the sand filling was a temporary thing, that the government did just to sell off… in a bid to in quote "profit making."*
> *(Ini, Phone interview, August 26, 2020).*

The interview excerpt suggests that the classist attraction to the island areas of Lagos are artificially created by the government through the concentration of urban development projects. These areas are expensive to live in and although wetlands and swamps surround the island, continuous development is taking place while increasing vulnerability to flooding for its inhabitants (see: Obiefuna et al., 2021). Based on data from Lagos State Government (LASG) (2013), Lagos Island's population is an estimated 2.4 million people while the mainland areas have an estimated population of 19 million people (see: Soyinka, 2018).

In addition, several participants highlighted how lack of capital forces people to live in certain physically vulnerable environments, lacking access to amenities. Lack of infrastructural development especially in informal communities increase flood vulnerabilities (Amoako, 2016; Lawanson et al., 2023). Many interviewees highlighted Ikorodu, a neighborhood in Lagos as physically vulnerable and cheap. *Obi,* a study participant specifically stated that:

> *"... I stay[ed] at Ikorodu before and it's the kind of place whereby people are just rushing in there because it's a new site and land is cheap… and everything about the places are cheap. Because of that, the government has not been able to develop the area….I'm talking about developing in the aspect of … if you're living in Ikorodu, most of the houses and streets… they don't have drainage systems and … in fact, the street that I stayed in…actually doesn't have a gutter."*
> *(Obi, Phone interview, September 10, 2020).*

Speaking on cost and flooding more broadly, *Katie* stated:

> *"But that depends on your capital… It depends on the kind of money you have. Because the areas… that experience flooding a lot, [are] cheaper. While the areas that don't experience flooding are costlier due to mansions and good roads in that area."*
> *(Katie, Phone interview, August 25, 2020).*

*Obi*i in the interview excerpt above, highlights that lack of infrastructural development contributes to the low cost of land in Ikorodu. The absence of drainage systems makes the community more vulnerable to flooding. Thus, elites tend to inhabit more structurally protected neighborhoods while others are relegated to vulnerable locations (Marks, 2015 study in Bangkok). Another participant stated that the cost of renting homes in waterlogged areas is cheaper than less vulnerable locations. Homeowners in these areas are also more likely to move out in the event of repeated flooding events and rent them out at low costs (*Peter, phone interview, August 28, 2020*). The cheap costs of rent is attractive to low income renters, exposing them to flooding. Furthermore, buildings are erected without consideration for possible drainage channels, creating the perfect environment for flooding events to take place. Ola an interview participant, claims that enforcement of building policies by the responsible agency in Lagos is fraught with allegations of bribery, where "anything can go if you [grease] the right palms" (Ola, phone interview, August 28, 2020).

Housing conditions and flood experiences

Rapid urban growth has led to limited housing availability in Lagos. A number of participants who also mention that the influx of people to the city has created congestion echoed this. To keep up with this demand, a participant, *Ife* said that there has been "encroachment into the waterways." Implying that urban growth drives housing development into vulnerable spaces to accommodate rising demand for homes. Slum settlements are a manifestation of housing problems in cities (Okwuashi and Ofem, 2014).

The vulnerability of informal settlements was highlighted in interviews. In particular, the experiences of people who live in structures called *bashers or shanties* from an outsider perspective. According to *Aisha*, an interview participant, bashers are low-cost wooden houses with no public utilities, that accommodate small-scale traders, food vendors, mechanics, and others, involved in the provision of basic goods and services to the surrounding neighborhood (Aisha, Phone interview, August 2020). Residents in these settlements offer informal but convenient shopping experiences, and other service opportunities, to people like Aisha who live in the surrounding formal neighborhoods. Hence, these shanty communities contribute essentially to the vitality of the city's economy albeit in less formal ways (UN-Habitat, 2003).

Aisha further describes her observation of the flooding experience of people who live in *bashers*[3], stating that they cope with flooding by temporarily moving after a flooding event, removing valuable household goods and in other cases, erecting platforms within their informal housing structures. Beyond that, bashers are often targeted for demolition to support beautification projects that cater to elites. Aisha specifically stated:

> *"And the next thing I know, they built a gate, and they started beautifying the place. That's what they call beautifying! … and you know… I was like… Ah! Remarking to my sister, I said 'Lagos doesn't have any space for poor people.' Or this Island doesn't have space for poor people."*
> *(Aisha, Phone interview, August 2020).*

Demolitions affect low-income groups the most, displacing them and exacerbating vulnerabilities to flooding (Ajibade and McBean, 2014). These demolitions highlight the interplay of politics and power in shaping flood vulnerabilities within the city. The government plays a significant role in contributing to vulnerabilities of the urban poor through its neoliberal projects within the city. For example, the LASG has received funding from the World Bank to implement slum upgrade projects within the

3 Aisha in the past had acquired a basher for her staff.

city (Olajide and Lawanson, 2021). Ironically, these projects have displaced people within these communities that were targeted to be served and instead luxury housing has been developed to cater to the needs of higher income groups (Olajide and Lawanson, 2021).

Land tenure, government acquisitions, and their contribution to flood experiences

State practices and policies of eminent domain contribute to increasing flood vulnerabilities among Lagos residents. Results from this study shows that, through eminent domain, the state has acquired land to accommodate road expansions and other infrastructural projects. In Lagos, government acquisition of land is predicated on Nigeria's land use decree of 1978. This act gave "management and control" of all land in each state to the military government within the state (Nigerian Military Government, 1978). When land is acquired by the state, an established land allocation committee oversees the resettlement of people whose land has been acquired (Nigerian Military Government, 1978). The local government on the other hand is in charge of compensating people whose land has been acquired (Nigerian Military Government, 1978). However in practice, resettlement and compensation has not always been successful (Aluko, 2012).

Results in this study show that people who live in places acquired by the government have had to move at short notice, disrupting their lives and livelihoods. This has also led people to move to locations that are more vulnerable to seek housing. This increases vulnerability to flooding and diminishes resilience. Many of these residents are renters, which means that government acquisitions go to the landlords with little to no compensation made to residents. Also, the compensation schemes have been found to be ineffective or incomplete (Lawanson and Agunbiade, 2018; Olajide and Lawanson, 2021). *Obi*, an interviewee stated that sometimes the government forcefully acquires these properties, when property owners "refuse to sell." *Obi*, in particular, received short notice (a few months) to move out of his current residence without prior notice about the sale of the property that occurred 2 years ago. Hence, it is necessary to consider the justice dimensions of how development in Lagos creates further burdens on the most vulnerable.

Furthermore, the state has discursively promoted urban development projects as ecologically sound, even though they cause disproportionate impacts on the urban poor (Ajibade, 2017). *Ini* highlights a key part of the issue, which is the government's interest in attracting private investment. According to *Kunle,* an informant, most of "the development in Lagos is economic and not ecological." The Eko Atlantic City project is a good example. *Ade,* an interviewee, claims that the Lagos State Government, in response to criticisms of the Eko Atlantic City project as being a contributor to a recent flooding event, stated that the project "was well planned," a "reclamation of land washed away by the ocean" and so, not the "cause" of flooding. *Ade* stated that the government attributed flooding to be a "natural phenomenon." This further establishes how through discourse, transformations of the urban environment are promoted and enacted to benefit certain groups of people while disproportionately harming others (Peet et al., 2010; Ajibade, 2017). In the case of Eko Atlantic City, poor vulnerable groups have been harmed by displacement while elites are the target beneficiaries of these urban development projects.

Unregulated landowners

An important consideration for land regulation, sales, and ownership in Lagos are the traditional landowners, called *omo onile*. Lack of oversight by the authorities in Lagos on the activities of land owners contributes to flood vulnerabilities. Several interviewees highlighted their role in land and building practices and how that affects flooding. The omo onile are indigenes of Lagos with land rights, who have used this position to assert legitimacy to the city of Lagos (Akinyele, 2009). They are major players in the Lagos housing market, engaging in the land sales (Ayodele, 2017; Odunfa et al., 2021). General public perception of the *Omo onile* are not entirely positive, they are filled with unpleasant experiences of land contestations, violence, and extortions (Akinyele, 2009; Ayodele, 2017; Odunfa et al., 2021). In this study, informants spoke about how the *omo onile* are unregulated and engage in selling land without clear guidance on land use purposes. Many times, landowners sell land in flood prone areas driven by financial gain, often without the knowledge of an unsuspecting buyer. *Ade*, an interviewee stated:

> *"Sometimes, those [landowners], they do sell lands in waterlogged areas or canals to prospective buyers, just because they want money" (Ade, Phone interview, August 30, 2020).*

Differentiated flood responses

Results presented so far reveal that that flood risk is distributed differently across income groups and neighborhoods. Results have also shown the role of government-led projects and lack of infrastructural development in contributing to flood vulnerabilities, especially for the urban poor. This section presents results on how residents of Lagos have applied responses to flooding. Firstly, although physical vulnerabilities are distributed across various income groups, wealthy people can invest in more resilient structures, protection measures, and other response strategies that minimize vulnerabilities to flooding. Some interview participants noted that certain neighborhoods have better drainages than others, which is a function of income. Whereby, elites can facilitate their privilege to get the government's attention. This is demonstrated by *Ima*'s statement:

> *"Some get more attention than the others. Obviously, those who are higher income earners… those who are… we call them rich anyway… They get quick attention from the government. They know how to pull the strings, they make more noise, they get quick access to government attention. So, it's easier to maintain those areas where the richer ones are living. It is easier for them to get, you know… the attention of the government when things are not working well, than those who are the low-income earners." (Ima, Phone interview, August 2020).*

A second point when considering income as a factor that engenders flood vulnerability is access to resources (Lawanson et al., 2023). For example, interviewee *Ini*'s ownership of two houses—one on the island and another on the mainland, enables him to cope by moving temporarily during flooding events. Another interviewee equally spoke about seasonal migration options that wealthy people can harness, and also how some have trucks as a form of mobility which helps them cope during flooding vs. less costly, smaller car options. Staying in hotels after a flooding event was raised as a way that wealthier people cope with flooding. In multiple studies on disaster response and recovery during Hurricane Katrina (Elliott and Pais, 2006; Pastor et al., 2006) similar findings were observed, where wealthier residents were more likely to evacuate to apartment rentals and hotels along with disaster response unevenness across economic lines.

In cases where there is a general lack of responsiveness of the government, people with higher incomes mobilize their resources toward implementing flood coping strategies, individually and collectively. Resources that build adaptive capacity include information. *Kola*, an informant, mentioned that access to information helps people build secure housing structures. Whereby some people can afford experts like engineers and land surveyors, prior to building homes, while lower income people do not have the same luxury. This translates to poorer housing conditions that predispose people to more adverse flood impacts.

In addition, rapid development in Lagos has not resulted in concomitant investments in flood protection structures on the part of the government. Results show that many neighborhoods suffer from the absence of drainages, others experience blockage of drainages due to indiscriminate waste disposal, while others need drainage upgrades. Many times, the presence of drainages or lack of, is determined by the income capacity of residents. Study findings reveal that where the government fails to provide drainage systems, neighborhoods with capital organize, pull together resources and invest in drainage systems collectively for flood preparedness and/or response. According to Fourchard (2011) residents, not government authorities have mainly taken responsibility for development in Lagos.

Community-based responses: community development associations

In the absence of adequate amenity provisions and flood management, findings from this research study suggest that community-based responses have played a significant role in flood management and have the potential to be an effective approach to climate adaptation. Waste management practices in the city is an example. Municipal waste contributes significantly to flooding in Lagos (Gandy, 2006; Douglas et al., 2008; Okwuashi and Ofem, 2014). Some interviewees attribute this to lack of waste bins and systems of waste collection that enable proper waste management. However, the failure of government in providing this essential urban municipal service places the burden on individuals and households to come up with their own waste management practices. This is demonstrated in this statement:

> *… I go to the market and buy a refuse [bag]. At the end of every 3 or 4 weeks, I have to move from my house… I have to trek to the expressway because that's where people normally dump refuse.… There are some who will dump it on the main road while some dump by the roadside. Now… I dump by the roadside. I will tell you why! Because, when you dump by the roadside, the government is forced to come and pack them... I know it is not ideal for me to dump by the roadside, but that is the best I can do! I cannot dump in those gutters around my street because I know I'll be helping the flood. So, the best I can do is to go dump by the roadside.*
> *(Femi, Phone interview, September 11, 2020).*

The above statement demonstrates the burdens on residents to device strategies to manage their municipal waste. However, not every resident is able to do this, so this creates ripple effects, increasing flood vulnerabilities in the city. Even though the government has enabled private sector providers (PSPs) to support municipal solid waste management in Lagos (Akiyode and Sojinu, 2006), interviews emerging from this study show pros and cons of this arrangement. A major problem of PSPs in Lagos, echoed by a few participants, is that they are not enough of them to cater effectively to all neighborhoods. Secondly, some interviewees expressed criticism of PSPs in terms of their inefficiency and inability to meet up with scheduled pick-ups. Informants expressed that low-income neighborhoods are more affected. This is because PSPs claim that the reason for their inefficiency is due to inaccessibility of neighborhoods with bad road conditions. In the absence of waste collection, people have engaged in indiscriminate dumping of waste, further exacerbating flood issues in these neighborhoods. However, in response to these challenges, communities have organized to augment the failure of the government in providing waste management. Interviewees mentioned that organized neighborhoods implement community-policing strategies to monitor improper waste dumping in order to mitigate against future flooding events. Community Development Associations often perform these monitoring efforts. These community-based strategies can allow for monitoring and compliance among community members (Ostrom, 1990).

On CDA's according to an interviewee, "*… people just forget about government and then people started their own government by themselves" (Olaolu, Phone Interview Participant, September 14, 2020).* Interestingly, CDAs were originally set up by the government to promote public participation in urban governance (Muse and Narsiah, 2015), and for open communication with the local government on community needs for planning (Oyalowo, 2021). The LASG itself has engrained CDAs into law, itemizing rules of conduct/organization (Oyalowo, 2021). Although, as in the case with Olaolu's statement, some community members have come to see CDA's as separate from the government. For others, CDA's have offered an opportunity to gain direct access to the local government on issues that affect the community, for example around transformers for electricity and on flood issues.

For neighborhoods across all income groups, the data suggests that the ability to organize was key to successful implementation of flood management strategies. In the words of Ade an informant,

"…we have our chairman, we have our patron, we have our treasurer… so we all contribute to ideas on how to solve the flooding issue." (Ade, Phone Interview Participant, August 30, 2020). Although, findings also suggest that high income and low-income neighborhoods organize around different priorities, that is, some across waste management to curb floods and others around drainages. In certain high-income neighborhoods, waste seemed to be less of a factor in flooding, and more on the physical topography and building policies. However, it is important to note that overlaps exist in priority areas of flood management irrespective of the income levels of neighborhoods (Fateye et al., 2021). *Aisha,* an interview participant *(Phone Interview, August 25, 2020*), who lives in a high-income neighborhood confirmed this. She said waste management in her prior and current neighborhoods (both high-income) were "efficient"; the main challenges in her current abode is the high density of housing developments. She claims that neighborhoods on the mainland have more waste issues because they are unable to organize effectively, compared to high-income neighborhoods, and because the government fails to play their role in waste management. Although, interviews also showed that in some cases there is more support from government on flood management strategies when communities organize and may have already implemented coping strategies.

Overall, the grassroots nature of CDAs and the belief, by at least some residents, that they are a means of advancing a responsible approach to flood mitigation is encouraging. However, there is further need to interrogate the efficacy of such entities in future studies. For more on CDAs and related projects in Lagos, see Akinsorotan and Olujide (2006) and Akinyemi (2020).

Discussion and recommendations

Lessons for a transformative approach to resilience

Thus far, this paper has revealed resident attitudes about flooding from individuals across a spectrum of vulnerability levels. Vulnerability to flooding in Lagos, as described by interview participants falls along the lines of income, housing conditions, unregulated land use and policies of acquisition. Income, on one hand plays a role in the scale of impact, the ability to cope with, and recover from flooding events (Marks, 2015). On the other hand, failure to provide basic infrastructure and municipal services especially in areas where the poor reside increase the vulnerabilities of the urban poor to flooding. Hence, results emphasize the need for attention on socio-political dimensions in producing flood risk to adequately address flood vulnerabilities.

Furthermore, organizing and collective action emerged in this research as a significant way through which neighborhoods respond to flooding. In particular, community development associations have been useful toward implementing flood management strategies. Interviewees describe specific interventions such as drainage systems and waste management to prepare for and to control flooding. Furthermore, CDAs have been used as vehicles to collectively present community interest to the government and toward localized action on issues. Therefore, we argue that these localized efforts contribute to transformative resilience and that these "endogenous" sources of resilience (Ziervogel et al., 2017) should be enabled in the implementation of climate adaptation strategies in Lagos, and places with similar structures. We find that localized efforts fill gaps created by urban governance failures where people are left without a choice but to seek ways of adjusting to the realities of climate change. Although reliance on bottom up resilience strategies places burdens on citizens to take action. It is also necessary to acknowledge and support such efforts. Donors, multilateral institutions and NGO's can target these existing efforts toward building urban resilience in places like Lagos.

Noteworthy, it important to anticipate and curb potential issues that may arise with community-based institutions like the CDAs. Gender representation is a key aspect. Studies have highlighted the uneven representation of men in CDAs (Akinsorotan and Olujide, 2007; Oyalowo, 2021). Others have shown undue external influences by government or traditional rulership within CDAs to push certain agendas (Muse and Narsiah, 2015). There have been tensions with local government authorities (Oyalowo, 2021) and co-option of power by CDA leadership (Muse and Narsiah, 2015). These are legitimate concerns that should be anticipated and curbed. Hence, there is need for further research on CDAs and urban resilience in Lagos. In particular, insights on community-based strategies to curb flooding in informal settlements will be beneficial.

Most importantly, addressing the underlying governance issues that produce flood risk in Lagos is critical. Despite local efforts, the role of effective urban governance in response to climate threats cannot be diminished (Leal Filho et al., 2018). Institutional dimensions are necessary for climate resilience (McClymont et al., 2020; Sono et al., 2021). Sono et al. (2021) outline "transparency, access to information, control of corruption and fraud, accountability, participation and engagement" as indicators of resilience. We find in our study that these challenges exist in urban governance in Lagos. For example, the vulnerability of renters displaced through eminent domain practices illuminate issues with engagement and should be addressed. Engagement with community groups should be prioritized (see: Harris, 2015), involving not just property owners but also renters. When land is acquired for development projects, leading to the displacement of people, it should be ensured that the purpose of the projects should benefit those who will be affected (Harris, 2015). Systems of accountability must be put in place to check incidences of bribery that encourage the construction of buildings in vulnerable locations. Overall, efforts must be made to address the socio-economic and political factors that produce flood risk and vulnerabilities in Lagos.

Conclusion

This study has attempted to examine flood vulnerabilities in Lagos within the wider socio-political context. Results reveal that flood risk is produced through state actions and inactions related to the provision of necessary urban amenities, infrastructure, and enactment of policies that curb flooding. Furthermore, results for this study demonstrate that low-income groups experience unique

vulnerabilities because they lack the necessary economic resources to avert or cope with flooding. The urban poor are also forced to live in flood prone areas due to government practices of demolitions and evictions. Unregulated land sale activities of landowners put unsuspecting buyers at risk of purchasing land in flood prone areas. Whereas others are driven to these flood prone areas due to cheap prices of land or rental homes. Where the state fails to take on infrastructural and management functions aimed at curbing floods, residents often the elite can appropriate resources to help them address flooding.

Through community-based strategies, residents may be able to manage flood issues. Community Development Associations in particular were highlighted by informants as a solution to some of Lagos's urban challenges at the neighborhood level, confirming similar findings by Akinsorotan and Olujide (2007). These organizations, with proper organizing, pull together resources and share information to implement flood management strategies. Communities with functioning CDAs have successfully implemented structural and non-structural measures for flood management. Considering Lagos' urban and governance challenges, this study proposes that these localized actions be targeted and supported to build urban resilience toward climate impacts in Lagos.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Syracuse University IRB. The participants provided their written informed consent to participate in this study.

Author contributions

SE worked on the conceptualization, data collection, methodology, analysis, and writing of this manuscript. LT contributed to the development, supervision, review of the current manuscript and will additionally be in part responsible for data analysis, interpretation associated with and further drafting associated with any requisite revisions, and joint approval of the final version. Both authors contributed to the article and approved the submitted version.

Funding

This research was supported through funding from two grants: the Randolph G. Pack Environmental Institute Research Travel Grant (2019–2020) and the Moynihan Institute and MASU/Goekjian Summer Research Grant (2020). Sponsors were not involved in the design, data collection, analysis or interpretation of data for this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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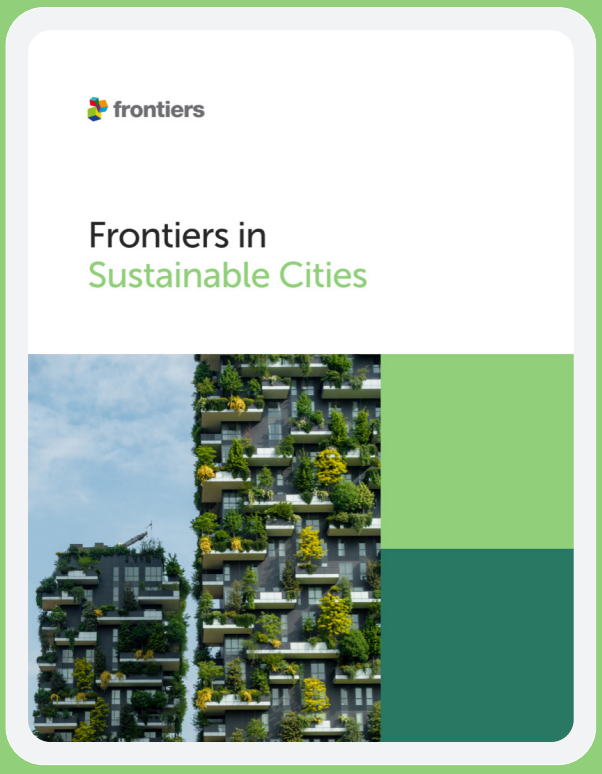

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