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EDITED BY
Cristina Matos,
University of Trás-os-Montes and Alto Douro, Portugal

REVIEWED BY
Andreea Nita,
University of Bucharest, Romania
Viviana Pappalardo,
University of Catania, Italy

*CORRESPONDENCE
Joshua D. Applegate,
applegaj@oregonstate.edu

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Using content and comparative analysis to contextualize the criteria for urban resiliency planning from international and US cities perspectives

Joshua D. Applegate[1]* and Jenna H. Tilt[2]

[1]Environmental Sciences Graduate Program, Graduate School, Oregon State University, Corvallis, OR, United States, [2]Geography Program, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR, United States

This study focuses on how the term "urban resiliency" and other related terms are operationalized across spatial scales. The European Union and United Nations established international goals, targets, and the specific measurable indicators with both the *European Green Deal* and their *2030 Sustainable Development* Goals (SDGs) to address climate change, with overarching goals of becoming the world's first carbon neutral continent. Much of this work to "green" cities falls under the concepts of urban resiliency, Green Infrastructure (GI), and ecosystem services (ES). This study seeks to understand the criteria considered for planning, development, implementation and maintenance urban resiliency at city and international levels. By contextualizing and clarifying broad terms like *resiliency*, *ecosystem services*, and *Green Infrastructure* for planners, politicians, and people within communities, our comparative analysis provides detailed understanding of the similarities and differences between plans from a national perspective, along with analysis of city-to-city comparisons. Our results suggest there are differences in focus regarding key aspects of resiliency, as well as the strategies suggested for resilient cities. Key differences were found in the importance placed on transportation, the future role of Green Infrastructure, and definitions of ecosystem services. These differences may have potential impacts on outcomes for resiliency project development and maintenance.

KEYWORDS

green infrastructure (GI), sustainable development goals–SDGs, urban resiliency, environmental services, Atlanta (Georgia, USA), Portland (Oregon, USA)

Introduction

This research focuses on urban resiliency planning and the process of greening cities, specifically when pertaining to the development and use of Green Infrastructure. With urban populations projected to increase to include about two-thirds of the world's population by 2050, mounting pressures from this influx and the influences of climate change are set to strain built environments and infrastructure (Masnavi, 2019; United Nations, 2014}. Cities already account for 75% of energy consumption, 60% of potable water usage, 80% of wood consumption for industrial purposes and 80% of global greenhouse gas emissions (Grimm et al., 2008). They are implicated in the worsening of climate change, through increased Urban Heat Island (UHI) effects, reduced biodiversity, and increased risk of natural disasters

(Rittel and Webber, 1974; Degg, 1992; Dreier et al., 2001; Grimm et al., 2008; Shandas, 2010; Head and Alford, 2015). Urban ecologists, academics, and policy makers have all called for city governments to play a role in identifying strategies to combat localized climate impacts and work toward a sustainable urban future (Dreier et al., 2001; Grimm et al., 2008; George et al., 2009; Shandas et al., 2008; Iwaniec et al., 2019).

At the global scale, the European Union's *Green Deal* and *2030 Sustainable Development Goals* (SDGs) established a uniform set of goals aiming for climate neutrality with the intent of making cities "inclusive, safe, resilient, and sustainable for all"{Diaz-Sarachaga et al., 2018; UNDP, 2021}. These ambitious goals are accompanied by a suite of measurable indicators to mark progress towards these goals. (Boluk et al., 2019; Iwaniec et al., 2019; Matsler et al., 2021) Many cities around the world have responded to these calls by utilizing comprehensive urban planning approaches in recent years, including increasing the development of Green Infrastructure and other sustainable practices. European cities are expected to produce data based on SDG indicators to provide evidence of progress towards meeting SDGs. However, US cities lack similar sustainability guidance at the national level. Due to the lack of a unified approach regarding the establishment of nation-wide definitions and indicators of resiliency for US cities, we seek to identify the commonalities and differences in how urban resiliency has been operationalized and implemented when viewed at the international scale.

Resiliency literature and the tools used to reach the objectives set by SDGs can have loose definitions that vary between government agencies, NGOs, and academia. The term has been utilized over a wide range of disciplines, beginning in health and wellness and psychology, and more recently in planning and natural hazard mitigation and adaptation with the its use by the UN Office of Disaster Risk Reduction (McGill, 2020). The UNDDR text, Making Cities Resilient, provides a 10-point checklist, a common sense approach to planning for urban resiliency that is divided between physical/environmental and institutional concerns (Johnson and Blackburn, 2014). UN-Habitat provided a more exact definition, with expectations for buildings ". . .to absorb the damages due to an external shock and to quickly restore their state (to the same as before) the shock (McGill, 2020). Finally, Rockefeller/ARUP created the City Resiliency Index (CRI), which provides a comprehensive, technically robust, and globally applicable framework with sets of indicators, variables, and metrics that allow cities to understand baseline, and subsequently measure, local resiliency over time. There are four listed dimensions to CRI: a) health and wellbeing b) economy and society, c) infrastructure and ecosystems, and d) leadership and strategy.

Other terms used in conjunction with resiliency and sustainability in an urban setting is Green Infrastructure (GI) and Green Infrastructure Networks (GIN). GI is consistently promoted as a multifunctional set of tools in the urban planner's toolbox that provide a suite of economic, socio-economic, and environmental benefits while disconnecting from traditional 'grey' engineering based solutions for stormwater management, air quality, urban heat island, or general ecosystem service delivery (Benedict et al., 2012; Firehock and Walker 2015). The Environmental Protection Agency (EPA) defines GI more narrowly, focusing on the engineered technologies or vegetation that manages stormwater flow or water quality (Conway, 2020; Finewood, 2019). Within this research, we use Benedict et al., 2012 definition of Green Infrastructure and Green Infrastructure Networks. Definitional differentiation can be drawn from GI being primarily from the site level, while influencing the larger interconnected networks (e.g., Green Infrastructure Networks, or GIN) of ecosystems, elements, and technologies that provide social, environmental, and technological functions for the purpose of urban greening. Both engineered technologies and intentional vegetated practices used in cities can act as GI, delivering ecosystem services at the community level and contributing to the GIN of a particular city or region. Still, when it comes to consideration of urban Green Infrastructure, these plans are more often considered from a single scale, which tends to be localized.

Development of GIN at the city level is meant to "emphasize the quality and quantity of urban green spaces, their multifunctional role, and the importance of interconnections between habitats" (Tzoulas et al., 2007). Returning attention back to the site level, GI should take many forms, and should be encouraged to be varied, creative, and forward thinking (Benedict et al., 2012). Due to the realities of fiscal constraints and a preference for low-risk options at the city level, new development of Green Infrastructure (GI) is primarily focused on types that have been proven effective through empirical evidence, such as green roofs, green streets, bioswales, and tree canopy. (Benedict et al., 2012; City of Meerow, 2020). For some cities, the use of these specific technologies and development techniques do not appropriately consider water scarcity, drought, or climate region. With water scarcity and drought impacting 79 global big cities and tremendous pressure already being applied to urban water supplies, these cities underutilize the tool of GI because there are fewer empirically verified arid climate GI opportunities (Zhang et al., 2019).

Differences in goals and definition of purpose from the national level could contribute to a lack of a uniformed approach to resiliency in what this term means and appropriate strategies to implement resiliency for US cities and how they may vary from European definitions and approaches. Definitional or perceptual differences can extrapolate to gaps in benefits, missed opportunities for environmental service improvement, and decline in comparative health, wellness, and happiness of communities. It is therefore imperative to consider the language that is being used within resiliency planning from both the European and US perspectives to determine whether such gaps exist and how these differences may impact policy and practices. Therefore, in this study we seek to answer the following research questions: 1) What are the similarities and differences in definitions, indicators, and proposed strategies for urban resiliency and sustainability between US cities and The European Green Deal and the UN Sustainability Development Goals? 2) What differences should be addressed in future iterations of resiliency planning and why? 3) Do these differences indicate gaps that should be addressed in future iterations of resiliency planning and modeling in the future.

Materials and methods

Methods

To answer these research questions, we conducted a deductive qualitative and comparative analysis utilizing a methodological

framework originally developed by Hoover et al., 2021 that focused on incorporating environmental justice into the siting criteria for GI. We do not use the coding framework to ask the same questions, but instead use the framework to conduct a comparative analysis of key resiliency/sustainability planning documents from the EU, UN, and two US cities: Portland, OR and Atlanta, GA. The objective of this research is to better understand what resiliency concepts are factored into definitions, planning, and production of urban resiliency and GI development strategies. This study will be referring only to the findings for these two selected cities, and not generalizing beyond that. When this study references findings for 'cities' or 'US cities', this is being used to mean specifically the included cities of Portland, OR and Atlanta, GA. Supplementary Table S1 lists the selected documents used in the comparative analysis, and shows the affiliations for each of those documents.

GI benefits are often explained using terms like ecosystem services, which is also a term that lacks clarity and understanding across silos of language (Spirn, 1984). This study uses a definition of ecosystem services developed by the United Nations (2010) that groups those services into four categories. These categories are 1) provisioning services or the provision of food, fresh water, fuel, fiber, and other goods, 2) regulating services such as climate, water, disease, and pollination, 3) Soil formation and nutrient cycling, and 4) educational, aesthetic, and cultural heritage values. By developing sub categorical and categorical groupings that include the definitions of words like resiliency, GI, and ecosystem services, this research allowed basic comparative analysis of city resiliency plans and international guidelines to see if different groups working on projects from different scales and perspectives are still attempting to address the same issues.

Workflow and city selection

The study design followed a four step approach consisting of literature review and case selection, data collection and identification of sampling frame, data analysis, and results (Glaser and Strauss, 1967; Lewis, 1998). This study design also follows the four phases of iterative triangulation as a methodology, which include data collection, data reduction, data display, and conclusion drawing. The cities of Portland and Atlanta were selected from a list of 19 US cities for further analysis based on their proximity, the number of relevant and accessible documents, and their reputation as top examples of the use of Green Infrastructure (GI) for urban resiliency and futures planning.

1. *Literature Review and Case Selection:* The study starts with a literature review of prior studies on green infrastructure (GI) and urban resiliency to identify relevant cities for further analysis.
2. *Data Collection:* From the initial list of 19 US cities, Portland and Atlanta were selected for further analysis based on proximity, number of relevant and accessible documents, and their reputation as top examples of the use of GI for urban resiliency and futures planning. Data collection involved reviewing comprehensive planning and resiliency documents, and the number of documents reviewed is provided in Supplementary Table S1.
3. *Data Analysis:* The data collected was analyzed using a deductive qualitative and comparative analysis, incorporating a methodological framework developed by Hoover et al., 2021. The framework focused on incorporating environmental justice into the siting criteria for GI. The objective of the analysis was to better understand what resiliency concepts are factored into definitions, planning, and production of urban resiliency and GI development strategies.
4. *Results:* The study design followed a four step approach consisting of literature review and case selection, data collection, data analysis, and results. The process of analysis was iterative and involved the four phases of triangulation, which include data collection, data reduction, data display, and conclusion drawing. The results of the analysis will be referred to only the findings for the two selected cities, Portland and Atlanta, and not generalized beyond that.

The data collection process involved a review of comprehensive planning and resiliency documents, and a summary of the number of documents reviewed is provided in Supplementary Table S1. Cities and their materials were screened from an initial list of 19 US cities, and appropriate cases were then selected for further analysis. Using the four phases of iterative triangulation, this process of analysis of case data helping to shape conjecture, refine theory, and further develop the understanding of the coding process as it advances, allows for the distillation of information and the ability to formulate conclusions.

City selection was narrowed to Portland and Atlanta from a list of 19 US cities that were included in prior studies focusing on comparative analysis of GI plans at the city and site selection levels, (Hoover et al., 2021). The city of Atlanta is listed as having one of the highest number of plans available for academic review that are considered current, operate under the jurisdiction of the city (or approved by a city agency or government), contain content on Green Infrastructure, and are available in English, according to a recent study of more than 303 city planning documents across 20 major American cities (Hoover et al., 2021). The City of Portland has a unique history with the use of GI, and bolsters the existing GIN with over a hundred new green streets every year.

Selection was made based on proximity so as to provide opportunities for continued research on these same projects at a later date, along with the number of relevant and accessible documents. Both cities show an effort to have long term resiliency plans in place to improve the livability of the city and react to past and future traumas. Both cities are active in updating these plans and have produced actionable results regarding GI development in the past. Both cities are regarded as top examples of use of GI, the development of future GI, and an intentional focus on urban resiliency and futures planning. Documents were then chosen based on their relationship to comprehensive planning and resiliency, most recent and updated available versions pulled from. Many documents were excluded from this study that were either deemed too narrowly focused on a specific issue (i.e., transportation plans, site-specific plans, etc.), or because they were retrospective materials. A summary of the total number of documents along with the number of plans reviewed, and a breakdown of type, year, and title by city is provided in both Supplementary Table S1 and Supplementary Table A1.

Coding, prioritization, and scale

Using the Hoover et al., 2021 framework as a model, we applied the same seven code categories to the comprehensive resiliency plans to all planning documents. These codes include: Hydrologic (HYD), Logistics (LOG), Social (SOC), Economic (ECN), Transportation (TSP), Environment, and Other (OTH) (Table 1). Once these basic groups were established, iterative coding provided subcategories for each of the groups, creating a depth of detail necessary to determine nuanced differences in interpretation of language and expected outcomes of policy.

Application of this coding regime combined open and pattern coding utilizing Atlas.TI software. With this semi-flexible code, and iterative coding and review of all documents, the coding style allowed for overlapping codes, and the assignment of multiple codes for text or imagery when appropriate. International documents were only reviewed for the purpose of contextualizing the EU Green Deal and the UN SDGs, establishing protocol for the iterative coding of documents, and for definitional purposes. These documents were used in a constant comparative model to aid in comparing and understanding language. By comparing these documents to city-level examples from the US, differences in goals and actual outcomes can be identified (Creswell and Poth, 2016). Comparative analysis between the EU and UN documents and the city-level US examples help to develop differences between goals, and espoused and actual outcomes (Stroh, 2015).

All document coding was reviewed by an external reviewer to ensure clarity of purpose and adherence to the deductive and iterative coding schemes. 10% of the documents were coded by external researcher. Any concerns or disagreements between coders were discussed until consensus was reached producing a final codebook, varying from the original general framework to fit scope and purpose of research when appropriate (Supplementary Table A2). Once coding was finalized and completed, coding frequency and proportional distributions between cities resiliency plans and state-level (national and international) SDG documents all were analyzed.

Results: Criteria for resiliency planning

Our completed analysis is comprised of 1,785 coded entries across 7 categories and 27 subcategories. Results positively indicate a variance in the criteria of focus (e.g., main categories) between International SDGs and the comprehensive resiliency plans for US cities. The highest ranking category of focus for the international documents was Economic considerations, followed by Logistics, and thirdly by Social. Both US cities provided priority to Social considerations, followed by Logistics, and Environmental categories (Figure 1).

Economic criteria

Economic criteria are defined as criteria related to urban resiliency based on budget, cost, benefit-cost analysis, or opportunities for land or business development. This appeared to be the most important category for international documents pertaining to resiliency, but was clearly prioritized less with half as much focus being placed on this at the city level. Examples where this was a higher priority at the international level was direct policy for poverty and workers rights issues. This aligns with existing literature that emphasizes the importance of economic considerations in resiliency planning, and suggests that long-term economic implications of policies are left to international groups while operational tasks are left to smaller scales such as cities (Andersson, 2014). This finding does keep with literature regarding the importance of economic considerations when engaging with resiliency planning, and with Andersson, 2014 description of strategical consideration of long term economic implications of policy being left to international groups and operational tasks left to a smaller scale like cities.

The economic criteria group included subcategories of *cost*, *economic development, land development*, and *general economic planning*. Cost is defined within this study as the estimation of the price of completion, cost/benefit analysis, opportunity cost. Examples of cost could be found within each of the comprehensive plans, including each of the types of cost being evident at both the international and city scales. Economic development is defined as improving economic wellbeing and quality of life through the creation of wealth. Land development was defined as improving their physical environments to appropriately fit their needs. When normalized for the varying scale in document length, the data shows that the EU and UN documents focused on economic development as a key component of that resiliency (51.02%) (Figure 2). In Atlanta and Portland, economic considerations focus much more on experiential impacts (e.g., the opportunity cost of development on human experiences within their communities), the cost of resiliency in economic terms, and changing urban landscapes to better suit the needs and expectations of community members (City of Atlanta, 2017; City of Atlanta, 2021). Based on our research, cost was the most important economic criteria to the City of Atlanta (30.84%). Compared to international SDGs, city plans coupled land development much more with economic development. As an example of this from the materials, consider the Global Indicator Framework Goal 1: Ending poverty in all its forms everywhere. While this is concerning economic development, it does not couple with land development in the same way that examples from both US cities do, through land and community revitalization (3:1 p 1 in Global Indicator Framework after 2022;″22:311 p 129 in ATL Plan A Comprehensive Development Plan).

Cost playing the key role at the city level was evident throughout the materials, as each policy was usually accompanied by figures for economic cost/savings, or economic benefits with the land projects being proposed. Most projects are an attempt to improve communities to make them more resilient to economic or environmental shocks through economic investment and intentional land development practices. Cost played a more prominent role at the city level because more actionable projects at the site level were included in these documents, forcing a discussion of costs, cost/benefit analysis, and opportunity costs to be mentioned at a higher level. Attention at the international level was more focused on broader economic strategies that would provide these same resiliencies at a larger scale. International and city policies both tended to look to areas where resiliency issues were already existing, attempting to resolve trouble spots at their scale as

TABLE 1 Comprehensive list of coding: categories, sub categories, definitions, and examples of each from selected documents.

Category and definition	Sub category and definition	Coded example
Economic: Criteria related to urban resiliency based on budget, cost, benefit-cost analysis, or opportunities for land or business development	General economic concern: Criteria related to urban resiliency based on budget, cost, benefit-cost analysis, or general mention of economic impacts of action.	*"Our challenge for ambition is to leverage the disruption of change to unlock new opportunities for people to pursue their dreams in our city." -22:18 p 18, Plan A*
	Cost: The estimation of the price of completion, cost/benefit analysis, opportunity cost	*"Find ways to defray costs for industrial businesses to stay in the city. 8 Support local hiring and job training at industrial businesses." -22:135 p 75, Plan A*
	Economic development: . . .Improve economic wellbeing and quality of life through the creation of wealth.	*"HA 6 Protect and enhance the city's attractions to tourists and visitors and thereby support and stimulate business and industry. 7 Strengthen the economy of the city." -22:147 p. 79, Plan A*
	Land development: . . .Improve their physical environments to appropriately fit their needs	*"Higher density neighborhoods can create the economic conditions necessary for small neighborhood businesses to thrive." -22:3 p 11, Plan A*
Environment: Criteria related to urban resiliency planning based on non-hydrologic environmental priorities or concerns such as increasing resiliency or improving air quality.	General environmental concern: Criteria related to urban resiliency planning and general environmental outcomes, impacts, or scenarios.	*"Atlanta City Design Nature (2020) is the first complete urban ecology framework that identifies specific ways to improve access to nature, address environmental justice, and better protect, restore, and enhance Atlanta's natural resources. . ." -21:7 p 4, Plan A*
	Ecological: Concerned with the relation of living organisms to one another and to their overall physical surroundings.	*"Natural Systems and Resiliency This element builds on Atlanta City Design: Nature, the first complete urban ecology framework for the city published last year" -21:30 p 18, Plan A*
	Environmental Justice: The addressing of unfair exposure and harm caused through exposure to environmental harms, specifically focusing on policy and practice that impacted marginalized communities with resource extraction, hazardous waste, and inequitable exposure to environmental harms.	*"Atlanta City Design Nature (2020) is the first complete urban ecology framework that identifies specific ways to improve access to nature, address environmental justice, and better protect, restore, and enhance Atlanta's natural resources." -21:5 p 4, Plan A*
	Soils: Concerned with the layer of earth from which plants grow, typically consisting of a mixture of organic remains, clay, and rock particles.	*". . .the BeltLine's first urban agriculture site, opened in December 2014. The 3.8 acre site has been transformed from two contaminated industrial sites plagued by erosion and soil depletion into a model privately operated organic food production site, which sells locally grown produce to the community. " -21:3 p 32, Atlanta Resiliency Plan*
	Air Quality: The degree to which the ambient air is pollution-free, assessed by measuring several indicators of pollution.	*"Health impacts from diesel exhaust Black carbon, a short lived climate pollutant, poses a risk to public health and increases the impact of climate change regionally through localized warming. . ." -32:74 p 29, Plan A*
	Ecological Habitat: The area of resources used by a specific species or an assemblage of animals and plants together with their abiotic environment.	*"The urban forest canopy, natural areas, biodiversity and habitat corridors and green roofs can be found throughout the community." -22:18 p 18, Plan A*
	Response To Climate Change: References within urban resiliency plans to the long-term shifts in temperature and expected weather patterns for communities	*"The region's buildings, infrastructure, and natural and human systems are prepared to recover quickly from the impacts of a. . . changed climate such as flooding, landslides and heat waves." -22:36 p 111, Plan A*
Hydrologic: Criteria related to urban resiliency to manage the quality or quantity of stormwater, natural water systems, or water supply	Stormwater Management: The process of controlling the runoff that comes primarily from the built environment, such as parking lots, driveways, rooftops, and roadways.	*"CW 15 Ensure lots have adequate open space and permeable surfaces to manage stormwater." -22:74 p 51, Plan A*
	Water Quality: Describing the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose.	*"03. Watersheds. Address localized flooding and water quality impacts from stormwater runoff, while improving the resiliency of Atlanta's watersheds." -22:265 p 119, Plan A*
	Water Supply/Service Availability: The source, means, or process by which water is supplied to the community. Can include means such as hard/grey infrastructure required, expertise provided, etc.	*"The water consumed by the City of Atlanta comes entirely from the Chattahoochee River." -26:45 p 32, Atlanta Climate Action Plan*

(Continued on following page)

TABLE 1 (*Continued*) Comprehensive list of coding: categories, sub categories, definitions, and examples of each from selected documents.

Category and definition	Sub category and definition	Coded example
Logistics: Criteria related to urban resiliency based on physical observations, spatial constraints, professional expertise, and consideration of implementation processes.	General logistics: Criteria related to urban resiliency based on physical observations, spatial constraints, professional expertise, and consideration of implementation processes for how tasks are accomplished and maintained.	*"Enhance scientific research, upgrade the technological capabilities of industrial. . ." -3:57 p 11, Plan A*
	Feasibility: Consideration of the degree of ease a task can be completed, can include spatial and financial	*"Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means." –*3:8, *p 2, Plan A*
	Field Observations: A qualitative data collection method which is used to observe naturally occurring behavior of people and places.	*"NPU 1 Ensure NPU boundaries and processes are updated regularly." -21:55 p 24, Plan A*
	Leveraged Opportunities: The ability to influence action or the completion of specific tasks through policy, incentivization, or relationship building.	*"The CDP shows the important relationships between land use, transportation, housing, economic development, nature, historic preservation, and other aspects of city building." -21:1 p 2 Plan A*
	Ownership: Consideration of partners/stakeholders in specific projects	*".fabric by connecting to the street network and the creation of block sizes that are compatible with adjacent/existing neighborhood character. 9 Repair existing sidewalks and ensure sidewalks are constructed for all new development." -22:20 p 50, Plan A*
	Scale: Consideration of projects and their impact on the greater or smaller scales of production for the development of urban resiliency	*".indicators managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed" –*3:15 *p 2, Plan A*
Social: Criteria related to urban resiliency based on resident or neighborhood engagement or involvement, increasing access to green space for cultural or social benefits, resident health, educational opportunities, or environmental justice or equity.	Community: Urban resiliency development with the intention of the improvement of culture, access to public engagement, and the building of an overall sense of unique community, often confined to the neighborhood level.	*". . .Atlanta's history is built on the stories, cultures, memories, and identities of the city's people and places." -22:14 p 17, Plan A*
	Education: The cultivation of public education opportunities both on and off school grounds. This can include workshops, feedback groups, and non-profit coordination.	*". . . Foster civic pride in the beauty and noble accomplishments of the past." -22:146 p 79, Plan A*
	Green or Open Space: Parks, the increasing of tree canopy cover or greenspace across the city, and more specific investment in areas of low current canopy cover, higher surface temperatures, and fewer opportunities for access.	*". . .Public Spaces Create vibrant public spaces designed for people." -21:47 p 20, Plan A*
	Heat Exposure: Contact between a person and an indoor or outdoor environment that poses a risk of increases in body core temperature and/or perceived discomfort due to raised surface temperatures.	*"Urban heat island effect is the increase in air temperature that results in part from the replacement of trees and other vegetation with buildings, roads and other heat-absorbing infrastructure. . ." -26:62 p 44, Plan A*
	Health and Wellbeing: A state of physical, mental, and social health, not merely the absence of disease or infirmity,	*Improve public health, and overall appearance and quality of life in and around the areas by strengthening code enforcement and encouraging compliance and clean-up." -22:86 p57, Plan A*
	Livability: Describes the frame conditions of a decent life for all inhabitants of cities, regions, and communities. This includes both physical and mental wellbeing. Livability is based on the principle of sustainability.	*"Continued growth can allow Atlanta to become a more equitable, inclusive, and accessible city to live in." -22:1 p 11, Plan A*
	Public outreach: . . .Incorporative community preference, feedback from neighborhoods from prior engagement with the cities and government agency/policy.	*". . .Ensure every Atlantan knows their opportunity to participate in community-level civic processes." -21:53 p 24, Plan A*

(Continued on following page)

TABLE 1 (*Continued*) Comprehensive list of coding: categories, sub categories, definitions, and examples of each from selected documents.

Category and definition	Sub category and definition	Coded example
	Recreation: Focused on the social dynamics of place, use of space, and connectivity to opportunity for leisure.	*"Expand the range of public activities and attractors in the park including but not limited to events; recreation. . ." -24:122 p 61, Plan A*
	Safety: Considerations of increasing public safety, often through improvement of infrastructure and appropriate funding for upkeep and maintenance	*"Replace and update fire and police stations and emergency vehicles throughout the city." -22:349 p 148, Plan A*
Transportation: Criteria related to urban resiliency pertaining to the right-of-way, considering pedestrian or traffic management, or department of transportation projects.	General Transportation: Criteria related to urban resiliency and transportation projects, impacts on transportation, or influence decision making with discussion of ramifications on traffic.	*". . .recent population growth brings new jobs to the city, generates funding for transportation." -22:2 p 11, Plan A*
	Parking/Parking Lots: Criteria focusing specifically on the need for or reuse of excess parking, parking lots, or the impact of parking lots on heat island effects.	*"Criteria focusing specifically on the need for or reuse of excess parking, parking lots, or the impact of parking lots on heat island effects. . ." -22:122 p 71, Plan A*
	Right of Way: The legal rights, pertaining to urban resiliency projects, that establishes the usage or grants to pass along a specific route through grounds or property belonging to another. The intersectionality of pedestrian, vehicle, and transport traffic within a city.	*"Redesign high-injury corridors and intersections with the community and agency partners." -22:162 p 85, Plan A*
	Streets and Sidewalks: Criteria focusing specifically on pedestrian traffic along trails, roadways, and through communities.	*"Support foot, bicycle and other means of active transportation to access these greenways and blueways." -21:43 p 19, Plan A*
	Traffic: Criteria focusing specifically on the use of roadways, tunnels, and bridges for the movement of both goods, supplies, and people	*"that people everywhere in the city can enjoy better, safer access without relying so much on a car. Recommendations build on recent citywide plans and the creation of the Atlanta Department of Transportation." -21:22 p 10, Plan A*
Other	Exclude: The process by which a specific area or group are excluded from the expectation of urban resiliency planning.	*"I Weatherization Requirement — Explore removing the City Charter weatherization prohibition to allow requirements for energy efficiency improvements at the time of sale. Consider benefits and address burdens to low-income populations and communities of color in any future requirements"*
	Principle: a fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning.	*"Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation." −3:25 p 6, Global Indicator Framework*
	Transitional: Currently un or under-developed and present an opportunity for providing habitat until such time in the future as economic conditions make them desirable for development	Currently un or under-developed and present an opportunity for providing habitat until such time in the future as economic conditions make them desirable for development

they deemed priority. Eradicating poverty, while not a part of the city resiliency strategy, is still prioritized through the elevation and coupling of economic and land development (City of Atlanta, 2021; Shandas, 2010).

Logistics criteria

Logistics is defined as criteria related to urban resiliency based on physical observations, spatial constraints, professional expertise, and consideration of implementation processes. Essentially, it is the category tasked with the question of how each of these policies within a comprehensive plan will be implemented and maintained. The logistics of resiliency planning is wide-ranging in scale and are often job dependent. For example, considerations of how to promote tourism that in turn creates jobs and promotes local culture and products was labeled logistics. Something much more physical like building and maintaining resilient infrastructure can also be found under general logistical categories. Our findings were that international resiliency plans considered logistics and the coordination of plans slightly more than cities, but that for both scales logistics was nearly equally important.

Subcategories included *feasibility*, *field observations*, *leveraged opportunities*, *ownership*, *scale*, and *transitional planning*. Logistics is rated as the second highest category for international SDGs (24.46%) and for US cities when averaged (19.79%). While international documents focused heavily on feasibility and leveraged opportunities, US cities were more likely to consider how to improve properties already under their control, and to find ways of monitoring and maintaining ongoing projects. Feasibility is defined by the degree of ease a task can be completed, can include spatial and financial. A great deal of the feasibility examples for international

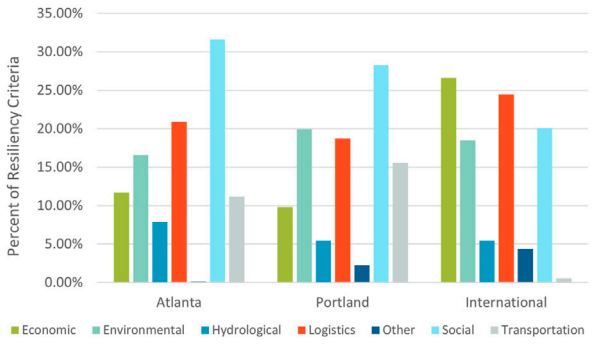

FIGURE 1
Initial criteria findings and comparison between US cities and international comprehensive resiliency plans.

documents were related to the financial and resource investment in key infrastructure in impoverished nations of the international community (3:8 p 2 in Global Indicator Framework, 2022). Similar facilitation concerns were seen at the city level as well, but scale of projects were usually focused to areas that have been neglected or victims of past environmental or economic injustices. These questions of facilitating resiliency through the moving of resources to areas in need seems to be a similarity across scales.

Leveraged opportunities, defined as the ability to influence action or the completion of specific tasks through policy, incentivization, or relationship building, are seen at both the city and international scale. These often look drastically different though in both policy and practice dependent upon scale (Andersson, 2014). As an example of this, the city of Atlanta is leveraging relationships within the community and planning experts to develop future land use (FLU) maps along with Character Area Planning to help guide the future growth and development in future years (City of Atlanta, 2021). This leveraging of opportunities was used in similar ways to find positive outcomes at the international level. Leveraged opportunities at the international scale were often to help benefit high cost or risk projects. This is also an area where injustices are attempted to be righted at the international scale, like with issues of the empowerment of women (3.28 p 7, Global Indicator Framework, 2022) energy efficiency (3.39 p 8, Global Indicator Framework, 2022), and economic productivity (3.43 p 9, Global Indicator Framework, 2022). This versatility and ability to have direct impacts on deliverables makes leveraged opportunities an important subcategory of the logistics criteria.

City documents made more linkages to the scale and contextualization of projects within the system that they were nesting within. For example, many of the ecological projects listed by the City of Atlanta were contextualized between the community they impact and the larger watershed. This type of contextualization of scale is lacking from the international documents, where instead the focus is on broader logistical issues and providing resiliency strategies across all borders. International documents tended to focus more attention on how to resolve existing global issues like poverty, access to resources like potable water, and the development of education systems that may lack curriculum on resiliency and sustainability practices.

Social criteria

Social is defined as criteria related to urban resiliency based on resident or neighborhood engagement or involvement, increasing access to green space for cultural or social benefits, resident health, educational opportunities, or environmental justice or equity. The social criteria of resiliency planning can be broad in scale but deal with community building, human interaction, and the human experience within the environment. Important subcategories within social were education, health and wellness, community, and public outreach. Many of these saw key differences at the sub categorical level.

The social category ranked as the highest overall priority for cities (29.89%). Social criteria also had the highest number of subcategories (11). These included *community*, *education*, *access to green open spaces*, *heat exposure*, *health and wellbeing*, *livability*, *public outreach*, *recreation*, *safety*, *visibility* and *general social concern*. While international documents maintained a relatively high level of attention spent on social issues (20.11%), the primary focus within the subcategories is general societal concerns, many of which were not as imperative when viewed from the perspective of cities. As an example of this, there are Global Indicator Framework goals that strive to "broaden and strengthen the participation of developing countries in the institutions of *"broaden(ing) and strengthen(ing) the participation of developing countries in the institutions of global governance. . . 16.8.1 . . .voting rights of developing countries in international organizations"*(3:119 p 20, Global Indicator Framework, 2022). These types of general societal issues are not as visible at the city level, which had a clearer focus on community, education, and public outreach.

The Community subcategory includes concepts related to urban resiliency development with the intention of the improvement of culture, access to public engagement, and the building of an overall sense of unique community, often confined to the neighborhood level. By definition, development of community happens at smaller scales (Hanley et al., 2007). International documents attempt to develop this sense of community through a foundation of economic and social security instead of direct community development and public outreach. For example, the city of Atlanta focuses on designing so that "(new) urban growth creates a dynamic environment for everyone (22.43 p 31, Plan A)", with future land use designations designed specifically to improve different aspects of the social criteria: public schools (education), fire stations and police precincts (safety), health centers (health and wellbeing), senior centers and water plants (livability) (22.57 p 40, Plan A). This shows not only why social was the most important category for cities, but also how the resiliency of our urban environments is reliant upon the resiliency of the people that live within them.

(Curry-Stevens et al., 2011) Cities are focused on improving upon existing benefits of living in urban environments, specifically to improve health, education, and job opportunity. With the social category having the highest overall percentage of overall coding (29.89%), higher levels of focus within these subcategories can be expected. For cities, resilient solutions included building sustainable communities (18.275%) that provide health and wellbeing (14.75%) through public outreach (13.12%). These overlaps show the holistic approach to many of the policies and programs that were resiliency based, especially those dealing directly with communities. Figure 3

FIGURE 2
Subcategory findings and comparison of economic codes between both cities and International documents.

illustrates how each of the subcategories are divided between both cities and the international documents. This provides a better understanding of how social criteria is broken down, and which subcategories see differentiation from international ones. Cities seem to be better equipped to handle the details of this type of resiliency planning, while at the international level documents tend to focus on broader social dynamics described above.

There is considerable overlap within subcategories between health and well-being and heat exposure, meaning that when something was coded for one it was often paired with the other. This shows that there is already a firm understanding that higher heat exposure can lead to risk to health and wellbeing. This overlap is similar to the one found between health and wellbeing and recreation, with understanding that focusing on one can have tertiary benefits that improve other environmental criteria. A another similar overlap is found between air quality, transportation, and health and wellbeing at the city level. Many projects and policies are proposed with the improvement of overall livability in the urban environment as the goal. Livability is defined as the frame conditions of a decent life for all inhabitants of cities, regions, and communities. This includes both physical and mental wellbeing. While citing air or water quality improvement improvements, tertiary benefits to the health and wellbeing of those impacted by the project, and comes into consideration when determining cost/benefit analysis. When packaged for policy delivery, this arrives in a form that speaks to improvement of livability, health, and community at the city level (22.65 p 48, ATL Plan A, 2021).

Access to green open space was highly cross-coded for similar reasons. Most projects or policies were not directly designed with the specific purpose of providing green open spaces. They were instead designed to improve neglected neighborhoods or watersheds (24.85 p 47, Central City 2035, 2020), repurposing land use for conservation (22.65 p 26, ATL Plan A, 2021) or for revitalization and recreation (22.35 p 26, ATL Plan A, 2021). While some of these plans do directly point to the benefits of equity of access to green open spaces, these are often projects at the city level and are cross-coded heavily with environmental justice.

Environmental criteria

Environmental criteria is defined as criteria related to urban resiliency planning based on non-hydrologic environmental priorities or concerns such as increasing resiliency or improving air quality. The environmental consideration within resiliency criteria were similar between international documents and those documents evaluated at the city level. Not only was there this similarity between scales (city-to-international comparison) but within scale (city-to-city comparison) the prioritization of environmental criteria is clearly important.

Environmental criteria played a major role for cities and international documents, with many of the cross-codes occurring within the same category (environmental). This speaks to the connectedness of the topic of resiliency to our relationship with the environment that we are living within. An understanding that to have resiliency, we must sustain and improve our relationship with the land that we are living on and the resources we consume to do so. Response to climate change is defined as references within urban resiliency plans to the long-term shifts in temperature and expected weather patterns for communities. While international plans can think of this response in terms of mitigating loss of life in major natural disasters, cities are being tasked with determining these changes in risk and adjusting their resiliency strategies accordingly. Both cities that were included in this study have comprehensive climate action plans. As an example, the City of Portland includes consideration of changes in precipitation patterns affecting streamflow and groundwater, recharge, and flooding, increases in risks of wildfire, drought invasive plant and animal species, and fish and wildlife populations (32.33 p. 13, Climate Action Plan, 2020). Each plan has extensive cross-coding with subcategories like public outreach (32.20 p 10, Climate Action Plan, 2020) to show the benefits to involved groups, usually developed at the watershed level.

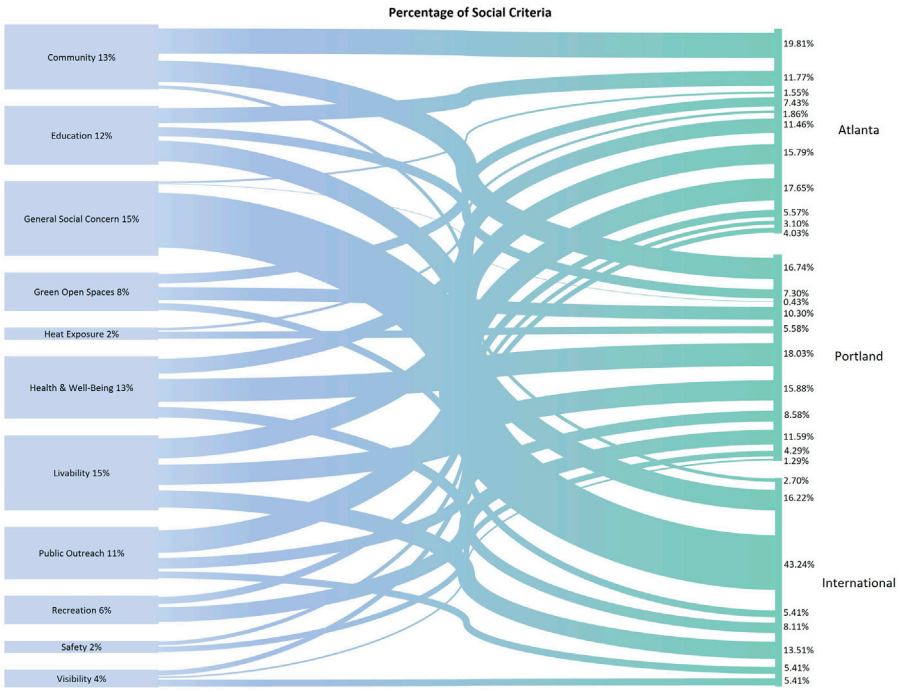

FIGURE 3
Subcategory findings and comparison of Social subcategories.

The subcategories focusing on *environmental justice* (17.33%) and *ecological habitat* (19.45%) provided for interesting findings from the city-to-city comparison. Environmental justice is defined as the addressing of unfair exposure and harm caused through exposure to environmental harms, specifically focusing on policy and practice that impacted marginalized communities with resource extraction, hazardous waste, and inequitable exposure to environmental harms (Sutter, 2018). Soil and air quality were given less attention at the international level. While both soil and air quality are outcomes of many of the actions prescribed throughout international SDGs, there were fewer instances of discussion of these topics compared to US cities.

Hydrologic criteria

Hydrological criteria are defined as criteria related to urban resiliency to manage the quality or quantity of stormwater, natural water systems, or water supply. Topics on water resiliency cover a broad scope, although played a much smaller comparative role than other criteria, mentioned less frequently within these comprehensive plans and international recommendations. Some examples of hydrological criteria being found in the international materials is Goal 6 of the Global Indicator Framework being to ensure availability and sustainable management of water and sanitation for all. This is a very different conceptualization from US cities that focused primarily on watershed improvement plans.

The Hydrologic criteria subcategories included: *stormwater management*, *water quality*, and *water supply availability* (see Figure 4). Stormwater management is defined as the process of controlling the runoff that comes primarily from the built environment, such as parking lots, driveways, rooftops, and roadways. An example of stormwater management being included in resiliency planning is the city of Portland making changes to stormwater reservoirs to be able to maintain higher quantities of runoff during major precipitation events. Water quality is defined as the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose. (BenDor et al., 2018) Water supply availability is defined as the source, means, or process by which water is supplied to the community and can include means such as hard/grey infrastructure required, expertise provided, etc.

Figure 4 provides a visual for the comparison of Hydrologic criteria and subcategories, showing both nuanced differences between cities and more stark differences between scales. When normalized, there is a tendency for cities to be focused on stormwater management at site and regional level, while international documents tend to have more *generally focused hydrological concerns*, and tended to have more focus on the water supply availability than did the US cities. Water availability and potability seemed to be more important for resiliency at the international level (30.0%). Atlanta and Portland instead focused upon improving or sustaining the water supplies that they have and have had in the past (Chattahoochee River and tributaries for Atlanta and Columbia Rive and tributaries for Portland), as well as designing improvements, and rehabilitation of hydrologic habitats around function and human purpose, as watershed improvement plans established by both cities (22.296 p 124, Plan A, 2021; 32.265 p 132, Climate Action Plan, 2020).

Comparatively, Atlanta and Portland tend not to focus as much attention on the availability of a sustainable water supply, usually touching on water quality when listing project benefits. For example, supply of available potable water for future resiliency concerns is not

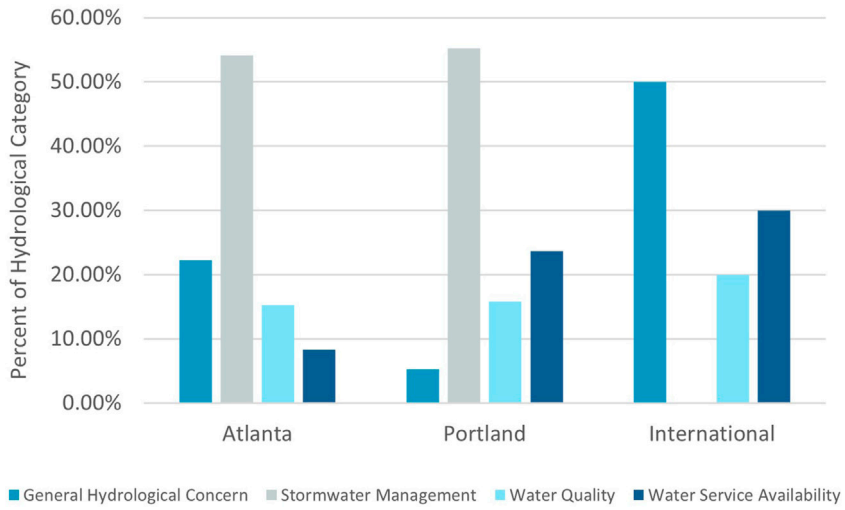

FIGURE 4
Subcategory findings and comparison of Hydrologic subcategories.

directly dealt with in any of the included comprehensive plans, at either the international or city level. Water quality is discussed more frequently in context of either hydrological habitat rehabilitation, or recreation (i.e., swimming). As an example of this, Atlanta's framing of the restoration of riparian habitat bases the benefits of this project in ecosystem health, value of ecological function, and for improvement of recreation. While water quality is acknowledged, it is not the primary objective of the project, and water supply availability benefits are only considered tertiarily.

Transportation criteria

Transportation is a theme that emerged from both the literature and the findings as still holding importance in considerations of resiliency, particularly for Atlanta and Portland. Discussion regarding transportation in these documents ties to other categories impacted, such as air quality. Examples of this can be found especially in the City of Portland comprehensive central city plan, with improvements in transportation being tied to increases in air quality and decreases in heavy metal pollutants (24.91, p. 50 Central City 2035, 2020). Optimizing street design and efficiency within this plan is linked to improvements in safety, health and wellbeing, and livability. The city of Portland specifically points to improvements in transportation to air quality and livability, including consideration of carbon costs and embedded energy costs of goods and services. Both cities provide more specific guidance regarding traffic and road maintenance plans than can be found at the international level. This is evident through both cities setting goals of "optimizing existing street networks" (Portland) and the development of policies in Atlanta to "maintain and improve accessibility and connectivity for pedestrians, transit riders, cyclists, and in-city and through-city freight traffic" (22.159, p. 83, Plan A, 2021; 14.91, p. 50 Central City 2035, 2020). Both cities studied placed an importance on lowering carbon emissions by providing more efficient means of travel and transport of goods and materials. This improvement extends beyond simply lowering emissions and takes into consideration traffic safety, especially in the city of Atlanta where the Vision Zero Program has established a goal of zero fatalities through the improvement of roadways, speed limits, transit access, and transformation of high-crash corridors to safer pedestrian friendly zones (22.160, p. 85, Plan A, 2021). Issues regarding transportation were less visible at the international level, and most dealt with cross-coded logistical issues like equitable access to travel across borders.

Other criteria

The "Other" criteria includes important subcategories that lacked appropriate categorical definition based on Hoover et al., 2012. Subcategories include *exclusions*, *principles*, and *transitional*. Exclusions is defined as the process by which a specific area or group are excluded from the expectation of urban resiliency planning. Principles is defined as a fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning. Examples of principles that influenced resiliency planning from an international perspective are ending malnutrition and violence against women (3.10 p. 2, Global Indicator Framework, 2022; 3.11, p. 2, Global Indicator Framework, 2022). Neither of these principles were mentioned at the city level, although each had their own plans to improve child health and improve economic opportunities for minorities and women. Transitional is defined as currently un- or under-developed land that present an opportunity for providing habitat until such time in the future as economic conditions make them desirable for development. Examples of transitional codes are brownfield or contaminated sites in industrial zones being cleaned and revitalized for future use, and examples of this type are found more often at the city levels. These remain in the other category because of the overarching nature of principles and the choice to exclude either a group or area

from the resiliency planning all together. Both are intrinsically having impacts on the rest of the projects and their categories.

Discussion

Our findings show how differing prioritization or a change in problem framing can impact resiliency planning at different scales. For example, air quality holding a high priority at the city level attributes to higher prioritization of transportation issues such as traffic. Cities see an opportunity to improve upon air quality in a way that also has many tertiary benefits that cross-code with livability and health. Cities planning documents identify transportation issues as being necessary for the continuance of business, but also as providing benefits toward resiliency goals. This is also in line with literature about local scales being responsible for operational undertakings like ensuring that infrastructure is developed and maintained according to the needs of the community (Andersson, 2014). Key differences were also found related to how ecosystems services are defined and incorporated in the documents analyzed. For example, our analysis found that international plans focused more on provisioning and regulating equity and access to improvement of working conditions and services like improved access to healthcare, while city planning documents for Portland and Atlanta focused on cultural services such as community wellbeing, recreation, and development of green open spaces.

Differences in the way problems are framed between Portland, OR and Atlanta, GA may contribute to the differences in coding for environmental criteria. For instance, many of the urban problems facing the cities of Portland and Atlanta were the same, but the framing was different between cities. As an example of this, Portland frames many issues using a climate-equity metric that helps to track the degree to which the equity considerations are integrated into the decision-making processes and implementation of the climate action plan (32.68 p 49, Climate Action Plan, 2020). This seems to help to position the city of Portland to have a higher likelihood of framing a problem as environmentally focused or in response to environmental concerns (i.e., environmental justice 23.61%) whereas these same issues were more often framed by the City of Atlanta as health concerns (i.e., heat exposure and health and wellbeing 24.50%). As an example, Atlanta frequently couples ecological improvements with maintenance improvements to existing parks and recreation facilities as general positive overall improvements in their policies and plans.

Implications of influential criteria for ecosystem services and green infrastructure definitions

Our findings show how differing prioritization or a change in problem framing can impact resiliency planning at different scales. For example, air quality holding a high priority at the city level attributes to higher prioritization of transportation issues such as traffic. Cities see an opportunity to improve upon air quality in a way that also has many tertiary benefits that cross-code with livability and health. Cities planning documents identify transportation issues as being necessary for the continuance of business, but also as providing benefits toward resiliency goals. This is also in line with literature about local scales being responsible for operational undertakings like ensuring that infrastructure is developed and maintained according to the needs of the community (Andersson, 2014). Key differences were also found related to how ecosystems services are defined and incorporated in the documents analyzed. For example, our analysis found that international plans focused more on provisioning and regulating equity and access to improvement of working conditions and services like improved access to healthcare, while city planning documents for Portland and Atlanta focused on cultural services such as community wellbeing, recreation, and development of green open spaces. Figure 5 illustrates how the ecosystem subcategories are referenced in US cities and international planning documents. This figure helps to visualize similarities in importance for policy development regarding ecosystem services and what those policies are actually targeting (Ervin et al., 2012).

Green Infrastructure techniques are often provided as alternatives within project proposals as both cost-saving and environmentally conscious techniques that provide key ecosystem services (Andersson, 2014). The most common use of Green Infrastructure currently involves stormwater management and flood mitigation during high precipitation events (Finewood, 2019; Firehock and Walker 2015). The difference in prioritization of stormwater management between scales suggests that Green Infrastructure is more applicable or appropriate at the city scale, where stormwater management and heat exposure concerns are greater. If Green Infrastructure is to be prioritized at a larger scale, it might be more beneficial if framed in a way to draw upon the benefits provided by the project beyond that of just stormwater management, such as cultural services (aesthetics, recreation) or regulating services (air quality improvements). This may increase the likelihood of adoption at larger scales, and in geographic regions that may not need the same types of GI due to variation in precipitation (Benedict et al., 2012). Our findings suggest that framing the implementation of GI with ecological, community, educational, and livability concerns could increase use at all scales and in different scenarios (Benedict et al., 2012).

Similarities between international and city scale

We found several instances of where the criteria emphasis between the US cities and international scales were similar, particularly at the category level for Environmental, Logistics, and Social categories. Furthermore, we found similarities within a few subcategories, particularly the hydrological subcategories. While hydrological category may have rated comparatively low as a priority during resiliency planning, the subcategories of water quality and water supply availability were given equal proportions of the resiliency plans at both scales. This finding is also supported with literature regarding GI implementation and management that find that these projects are primarily utilized for stormwater management (Baker, 2019; Benedict et al., 2012; Conway, 2020). If similar national level policies were implemented for heat exposure, for instance, GI usage

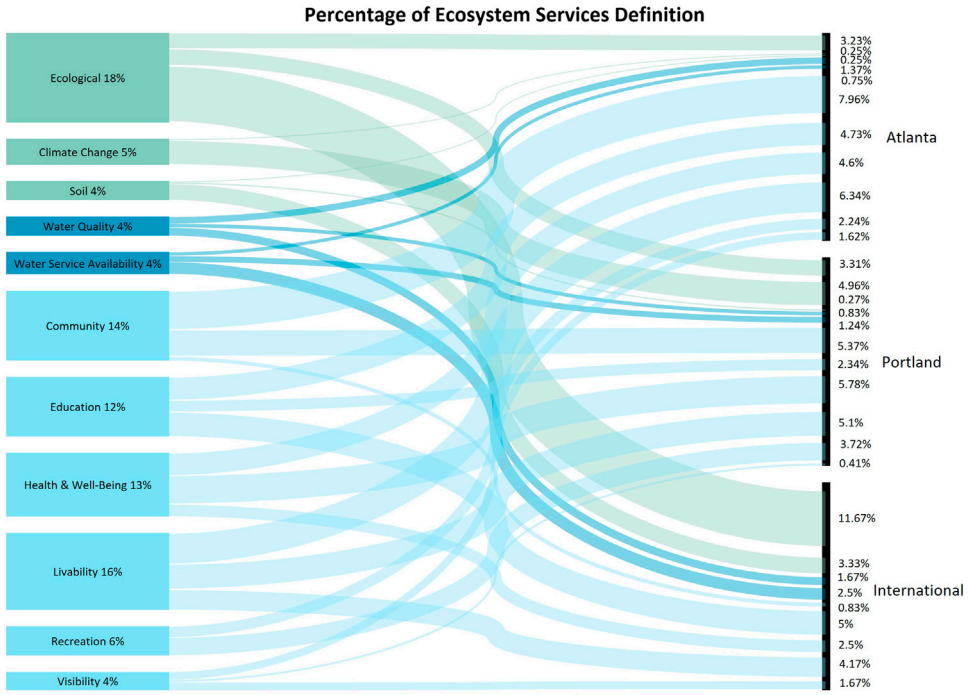

FIGURE 5
Example of visualization of the definition of ecosystem services.

might increase through the development of more tree canopy, green walls and roofs, and improvements to access to green open spaces.

Resiliency at its core is less dependent upon understanding the exact risks of the future and instead an attempt to tolerate increasing levels of uncertainty and the institution of broader programs to help absorb existing and new stresses that the urban environment might face (Rich, 2014). Our findings reveal that while at the categorical level (e.g., environmental, costs, social) we find many similarities between international and city documents, it is at the sub-categorical level we find more differences due to their geographic research and foci. Based on these findings and the existing literature that it fits into, key features of resiliency planning that are unifying (i.e., health and wellbeing, air quality, education, hydrologic) should be broadly defined for consistency and unity in plans and practice across scales. National scale programs and policies with general guidelines would help smaller scales like cities to be responsible to meet, creating an atmosphere for the creative development of resiliency solutions. These solutions may still be geographically or culturally unique, but still work toward common resiliency goals set at the international level. This is in line with current literature regarding strategies for optimizing resilient planning and large-scale interdependent critical infrastructure (Huang et al., 2018; Afrin et al., 2021).

Areas of distinct differences within and between categories

At the subcategory level of analysis, clearer indicators emerge of distinct differences in focus and intent within categories. Differentiation between scales and gaps in cross-scaling has also been noted in previous research and are reinforced by our findings (Borgström et al., 2006). For example, instances where there are differences found at the sub categorical level (i.e., social, logistics) present opportunities to tailor expectations and definitions of resiliency to their geographic place. For example, the sub-category of "social" shows distinct differences of focus between international and US city scale (Figure 3). Some of these differentiations are occurring due to expectation of role for resiliency planning between scale (strategical v. operational). An example of this is the percentage of social criteria, which is shown as a Sankey graphic in Figure 4. For example, it is imperative that city planning have clear directed goals and policies related to public outreach, whereas the international planning documents may support education and learning opportunities but lack specificity regarding implementation strategies (Nita et al., 2022).

Conclusion

In this study we determined that there are similarities and differences in strategy and understanding of resiliency concepts when viewed from a city-to-international planning perspective and there are differences within concepts like resiliency, ecosystem services, and Green Infrastructure from a city-to-city and a city-to-international comparison. These differences indicate opportunities that should be addressed in future iterations of resiliency planning and modeling. The differences identified between international and city scales in definition and utilization of key terms such as resiliency and sustainability are also noted in previous research and are reinforced by our findings (Borgström et al., 2006). Some of

these key differences are due to document purpose (e.g., strategical v. operational); yet other differences such as how societal benefits were perceived or the primary function and use of green infrastructure, were apparent even when the document type was similar between international and city scales. Our method of analyzing planning documents could be employed to review other cities, as well as providential or state-wide plans and allow for more comparison between these scales. Future analysis using this same method and analysis process to review urban plans at a single scale (i.e., cities), could provide clarification regarding the purpose for resiliency projects as well as providing greater integration between scales.

Study limitations

This research uses a deductive coding regime, developed for comparative analysis of urban plans for decision making regarding GI placement and environmental justice. We recognize that many international planning documents were not created specifically for urban environments, or with resiliency implications in mind. Due to methodological and funding limitations of this study, comprehensive determinations regarding resiliency planning at any scale would require additional research. This additional research could be done from the perspective of cities attempting to improve their own resiliency plans and would be more reliable with the inclusion of all applicable materials coming from this perspective in the future. Other previous studies have pointed to similar limitations, and alluded to the need for further focus on network analysis and GI development to better understand the relationships and dynamics of development, implementation, and maintenance of GI projects (Badiu et al., 2019; Borgström et al., 2006).

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

JA and JT contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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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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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2023.1103115/full#supplementary-material

References

Afrin, S., Chowdhury, F. J., and Rahman, M. M. (2021). COVID-19 pandemic: Rethinking strategies for resilient urban design, perceptions, and planning. *Front. Sustain. Cities* 3, 668263. doi:10.3389/frsc.2021.668263

Andersson, E. (2014) . Reconnecting cities to the biosphere: stewardship of green infrastructure and urban ecosystem services. *Ambio* 43 (4), 445–453.

Badiu, D. L., Nita, A., Iojă, C. I., and Niță, M. R. (2019). Disentangling the connections: A network analysis of approaches to urban green infrastructure. *Urban For. Urban Green.* 41, 211–220. doi:10.1016/j.ufug.2019.04.013

Baker, A. (2019). Spatial analysis of landscape and sociodemographic factors associated with green stormwater infrastructure distribution in Baltimore, Maryland and Portland, Oregon. *Sci. Total Environ.* 664, 461–473.

BenDor, T. K., Shandas, V., Miles, B., Belt, K., and Olander, L. (2018). Ecosystem services and US stormwater planning: An approach for improving urban stormwater decisions. *Environ. Sci. Policy* 88, 92–103. doi:10.1016/j.envsci.2018.06.006

Benedict, M. A., and McMahon, E. T (2012). Green infrastructure: Linking landscapes and communities. *Island Press*.

Borgström, S. T. (2006). Scale mismatches in management of urban landscapes. *Ecology and society* 11, 2.

Boluk, K. A., Cavaliere, C. T., and Higgins-Desbiolles, F. (2019). *A critical framework for interrogating the united nations sustainable development goals 2030 agenda in tourism*. Taylor & Francis

Borgström, S. T., Elmqvist, T., Angelstam, P., and Alfsen-Norodom, C. (2006). Scale mismatches in management of urban landscapes. *Ecol. Soc.* 11, art16. doi:10.5751/es-01819-110216

Conway, T. M. (2020). An analysis of green infrastructure in municipal policy: Divergent meaning and terminology in the Greater Toronto Area. *Land Use Policy* 99, 104864

City of Atlanta (2021). Atlanta's comprehensive development plan executive summary: Plan A. *Dep. City Plan*.

City of Atlanta (2021). Atlanta's comprehensive development plan: Plan A. *Dep. City Plan.*

City of Atlanta (2017). Resilient Atlanta. *Actions build equitable future.*

Creswell, J. W., and Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches: Sage publications.

Curry-Stevens, A., and Cross-Hemmer, A. (2011). The native American community in multnomah county: An unsettling profile

Degg, M. (1992). Natural disasters: Recent trends and future prospects. *Geography*, 198–209.

Diaz-Sarachaga, J. M., Jato-Espino, D., and Castro-Fresno, D. (2018). Is the Sustainable Development Goals (SDG) index an adequate framework to measure the progress of the 2030 Agenda? *Sustain. Dev.* 26 (6), 663–671. doi:10.1002/sd.1735

Dreier, P., Mollenkopf, J. H., and Swanstrom, T. (2001). *Place matters: Metropolitics for the twenty-first century*. Lawrence, KS: University Press of Kansas Lawrence.

Ervin, D., Brown, D., Chang, H., Dujon, V., Granek, E., Shandas, V., et al. (2012). Managing ecosystem services supporting urbanizing areas. *Solutions* 6 (2), 74–86.

European Union (2019). *EU green deal.*

European Union (2019). *EU green deal annex.*

Firehock, K., and Walker, R. A. (2015). Strategic green infrastructure planning: A multi-scale approach. *Island Press.*

Finewood, M. H. (2019). Green infrastructure and the hidden politics of urban stormwater governance in a postindustrial city. *Ann. Am. Assoc. Geogr.* 109 (3), 909–925.

George, L. A., and Shandas, V. (2009). Spatial patterns of air toxins in the region. *Metroscape.*

Glaser, B. G., and Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine De Gruyter.

Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., et al. (2008). Global change and the ecology of cities. *Science* 319 (5864), 756–760. doi:10.1126/science.1150195

Head, B. W., and Alford, J. (2015). Wicked problems: Implications for public policy and management. *Adm. Soc.* 47 (6), 711–739. doi:10.1177/0095399713481601

Hoover, F.-A., Meerow, S., Grabowski, Z. J., and McPhearson, T. (2021). Environmental justice implications of siting criteria in urban green infrastructure planning. *J. Environ. Policy & Plan.* 23, 1-18. 665–682. doi:10.1080/1523908x.2021.1945916

Huang, L., Chen, J., and Zhu, Q. (2018). Distributed and optimal resilient planning of large-scale interdependent critical infrastructures. In *2018 winter simulation conference (WSC)*(pp. 1096–1107). IEEE.

Iwaniec, D. M., Cook, E. M., Barbosa, O., and Grimm, N. B. (2019). The framing of urban sustainability transformations. *Sustainability* 11 (3), 573. doi:10.3390/su11030573

Johnson, C., and Blackburn, S. (2014). Advocacy for urban resilience: UNISDR's making cities resilient campaign. *Environ. Urbanization* 26 (1), 29–52. doi:10.1177/0956247813518684

Lewis, M. W. (1998). Iterative triangulation: A theory development process using existing case studies. *J. Oper. Manag.* 16 (4), 455–469.

Masnavi, M. (2019). Exploring urban resilience thinking for its application in urban planning: A review of literature. *Int. J. Environ. Sci. Technol.* 16 (1), 567–582.

Matsler, A. M., Meerow, S., Mell, I. C., and Pavao-Zuckerman, M. A. (2021). A 'green'chameleon: Exploring the many disciplinary definitions, goals, and forms of "green infrastructure". *Landsc. urban Plan.* 214, 104145. doi:10.1016/j.landurbplan.2021.104145

McGill, R. (2020). Urban resilience – an urban management perspective. *J. Urban Manag.* 9 (3), 372–381. doi:10.1016/j.jum.2020.04.004

Meerow, S. (2020). The politics of multifunctional green infrastructure planning in New York City. *Cities* 100, 102621.

Nita, A., Fineran, S., and Rozylowicz, L. (2022). Researchers' perspective on the main strengths and weaknesses of Environmental Impact Assessment (EIA) procedures. *Environ. Impact Assess. Rev.* 92, 106690. doi:10.1016/j.eiar.2021.106690

Rich, B. D. (2014). Principles of future proofing: A broader understanding of resiliency in the historic built environment. *Preserv. Educ. Res.* 7, 31–49.

Rittel, H. W., and Webber, M. M. (1974). Wicked problems. *Man-made Futur.* 26 (1), 272–280.

Shandas, V. (2010). Measuring with meaning: Grounding data in place, perspective, and practice. *Mak. EcoDistricts*, 98.

Shandas, V., Graybill, J., and Ryan, C. (2008). Are planners using ecosystem based management when developing environmental policy? Evidence from the pacific northwest (US). *J. Environ. Plan. Manag.* 51 (5), 649–664.

Spirn, A. W. (1984). *The Granite Garden: Urban nature and human design*. New York, NY.

Stroh, D. P. (2015). *Systems thinking for social change: A practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results*. Chelsea Green Publishing.

Sutter, P. S. (2018). *Environmental justice in postwar America: A documentary reader*. Seattle, WA: University of Washington Press.

UNDP (2021). *Global Indicator Framework for the sustainable development goals and targets of the 2030 agenda for sustainable development.*

Zhang, X., Chen, N., Sheng, H., Ip, C., Yang, L., Chen, Y., et al. (2019). Urban drought challenge to 2030 sustainable development goals. *Sci. Total Environ.* 693, 133536. doi:10.1016/j.scitotenv.2019.07.342