



Editorial

Rethinking urban resilience through multidimensional lenses

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Amid rapid and profound global environmental change, urban disturbances exhibit complex characteristics of multi-source interweaving, cascading propagation, and cross-scale diffusion. A single-dimensional cognition and response paradigm of urban resilience can no longer understand and address the practice-based problems in current urban resilience construction [1]. Cities function as deeply coupled complex systems, integrating technological, social, and natural subsystems. Accordingly, urban resilience does not rest solely on the robustness of technological infrastructures. Rather, it is equally contingent upon the disturbance-absorbing capacity of socio-ecological systems and the collaborative mechanisms of diverse actors [2]. Furthermore, revisiting the key challenges and systematically articulating problem-oriented core agendas for advancing urban resilience, through a practice-based and multidimensional lens, is pivotal to addressing persistent deficiencies in urban risk governance and to advancing sustainable urban development.

1. Urban resilience: Multidimensionality origins and practical challenges

The multidimensionality of urban resilience emanates from the fundamental attributes of urban socio-ecological systems, encompassing systemic complexity, the multiplicity of disturbance types, the multi-scalar nature of hazard impacts and responses, and the plurality of governance actors. As such, contemporary urban resilience practice confronts challenges across five distinct dimensions.

Diverse disturbances—Natural hazards (e.g., earthquakes, extreme downpours), anthropogenic disasters (e.g., industrial spills, infrastructure collapses), pandemics, cyberattacks, and trade disruptions—exert substantial impacts on urban operational integrity [3]. Moreover, the deployment

of emerging technologies may engender novel disturbance modalities. Against this backdrop, developing a universal framework for analyzing resilience across these multi-dimensional disturbances remains a critical theoretical challenge, especially amidst the inherent dilemmas of urban resilience practices.

Spatiotemporal heterogeneity—Urban areas undergo a dynamic disaster lifecycle, encompassing pre-disaster prevention, intra-disaster emergency response, and post-disaster recovery. Resilience strategies exhibit substantial disparities across these phases. Likewise, notable disparities exist in resilience strategies between short-term shocks and long-term stresses. Furthermore, localized hazard impacts propagate upward to macro-scales via extensive and intricate functional linkages, resulting in distinct resilience strategies across different scales [4,5]. Consequently, ongoing efforts to foster urban socio-ecological resilience urgently require balanced approaches and integrated frameworks to align multi-phase and multi-scale resilience strategies.

Systemic nonlinear coupling—The orderly operation of modern cities is highly contingent upon the organic synergy of diverse urban subsystems. By virtue of the nonlinear coupling relationships among these subsystems, hazard impacts propagate intricate cascading reactions across system boundaries, thereby precipitating cascading disaster amplification effects [4]. Fundamentally, the development of methodologies for identifying critical systems or nodes that precipitate cascading failures, alongside the formulation of intervention strategies to interrupt disaster transmission, constitutes an exigent technical lacuna awaiting remediation in urban resilience practice.

Demand differentiation—Amid disaster episodes, urban dwellers exhibit hierarchical and tiered needs [3], encompassing both universal commonalities and group-specific heterogeneous exigencies. Notably, disparities in physiological competencies and economic endowments across disparate demographic cohorts underpin substantive divergences in their core needs. In this regard, the precise delineation of vulnerable groups and the formulation of contextually tailored response frameworks constitute an exigent governance equity dilemma in resilience planning and practice that cries out for redress.

Multi-governance actors—Enhancing urban resilience hinges on synergistic collaboration among multiple stakeholders, namely governments, market entities, and community residents. Yet, contemporary resilience practice is plagued by a power-responsibility asymmetry among resilience-building actors. Specifically, governments prioritize emergency response over long-term stewardship; market entities gravitate toward high-return resilience governance domains driven by profit motives; community residents demonstrate inadequacies in risk perception and self-protection capacities. Owing to the lack of institutionalized collaboration mechanisms, effective cross-stakeholder linkage is absent. As a consequence, insufficient multi-stakeholder synergy constrains the evolution of disaster governance from emergency response to holistic resilience.

2. Practice-aligned core research agendas for urban resilience

Prior to deliberating on core research agendas, it is paramount to conceptualize urban resilience. When the city is construed as a holistic system, urban resilience is defined as follows: When subjected to shocks or stresses, a city sustains its core functionalities to facilitate diverse resident activities (e.g., habitation, commerce, employment, recreation, and mobility between these activity nodes) and safeguard residents' access to essential services. This definition transcends the resilience paradigm constrained to singular hazards (e.g., flood resilience, seismic resilience) or discrete systems (e.g.,

energy system resilience, transportation system resilience, healthcare system resilience). Instead, it prioritizes residents' livelihood and productive endeavors. Furthermore, this definition nurtures a more integrated analytical lens, enabling the transition from isolated single-system resilience to interactive complex-system resilience. Building on this premise, to address the five-dimensional challenges outlined above, four practice-aligned urban resilience research agendas are articulated, encompassing ontological cognition, methodological frameworks, and governance regimes.

Agenda 1: Analytical framework for urban resilience amid physical-social interactions

Examining the dynamic evolutionary characteristics of urban resilience across temporal and spatial scales helps transcend the research limitation of static assessment. After all, pursuing merely high-quality static equilibrium could potentially lead to nothing more than a deceptive security condition [4,6]. This stability is ostensibly secure; yet once it exceeds fixed thresholds, the consequences could be more severe [7]. Thus, the core agenda for resilience is not to build rigid structures, but rather to foster the capacity for dynamic adaptation amid perturbations.

Urban resilience is shaped not only by physical systems (i.e., technological and natural systems) but also by social systems. Interactions between physical and social systems may emanate from either external shocks or endogenous degradation (e.g., the senescence of physical infrastructure). Such interactive dynamics modulate the temporal variations in residents' access to services and resources—both during normal times and in disaster contexts. For instance, physical impairment of a facility precipitates the attrition or demise of its functionalities. This, in turn, reshapes the flows of diverse interacting components (e.g., people, materials, energy, information, and services) associated with the facility, which further precipitates the spatial reallocation of resources and services [4,8]. Ultimately, these processes impair residents' ability to maintain normal living conditions.

The core agenda of this perspective is to construct a generalizable analytical framework for urban resilience. By adopting a physical-social interaction lens, this framework not only captures differentiated resilience characteristics and their underlying mechanisms, but also traces the dynamic evolutionary processes of urban resilience across heterogeneous spatiotemporal scales, thereby clarifying its key influencing factors and driving regime.

Agenda 2: Impact mechanisms of interdependent systems on urban resilience and their synergistic regimes

The interdependence and synergy among urban systems manifest a duality. On the one hand, diverse urban systems form an organic whole through functional interdependence and synergy, collectively underpinning the fulfillment of residents' diverse needs. On the other hand, the intricate interconnections between urban systems render even those not directly impacted by perturbations unable to remain insulated amid risk disturbances [9]. In fact, local hazards may propagate via intersystematic relational networks, thereby triggering cascading failures.

Relative to unidirectional interdependence—e.g., water supply disruption resulting from energy system impairment or compromised medical service accessibility due to transportation system degradation—cascading failures driven by bidirectional interdependence exert prominent amplification effects. Specifically, local perturbations elicit oscillatory interactive perturbations and damages across systems with bidirectional interdependence, thereby substantially broadening the

scope of perturbation impacts [10]. For illustration, energy system disruption precipitates communication blackouts; conversely, this undermines energy system dispatching, which further culminates culminating in large-scale urban functional breakdowns.

Informed by complex system theory, the essence of urban resilience resides in the synergistic adaptive capacity of technological, natural, and social systems. From this vantage, a city is not a mere aggregation of its subsystems but rather a dynamically coupled complex shaped by the flows of humans, materials, information, services, and energy. For example, in mitigating extreme rainfall-induced flooding, enhancing urban resilience necessitates not only technological systems such as flood control infrastructure but also hinges on the mobilization capacity of community self-governance entities, cross-departmental collaborative governance regimes, and the flood regulation and storage functions of urban blue-green spaces.

The core agenda of this perspective resides in two interrelated dimensions. First, it seeks to develop an innovative methodological framework for comprehensively quantifying the impacts of nonlinear coupling characteristics of diverse urban systems on urban resilience. Second, it aims to establish a multi-system synergistic mechanism to enhance the city's adaptive capacity to a full spectrum of perturbations.

Agenda 3: Social heterogeneity in disaster exposure risk and equity-justice for resilience enhancement

The equity and justice lens constitutes an emergent agenda in urban resilience scholarship. Most contemporary urban risk mitigation and emergency response initiatives employ uniform criteria, thus lacking differentiated frameworks tailored to vulnerable populations and fragile locales. Nevertheless, equity in risk governance does not amount to the equal apportionment of diverse resources; instead, it ought to adhere to the tenet of needs-based adaptation and vulnerability prioritization. Divergent cohorts demonstrate substantial disparities in core demands for public goods pertinent to risk mitigation and emergency response—including emergency medical aid, accessible evacuation and relocation, essential livelihood provisions, and secure shelter amenities. Consequently, risk governance must reconcile equity across distinct groups, locales, and even generations.

Vulnerable cohorts—including the elderly, children, low-income demographics, and migrant populations—typically confront heightened exposure risks and attenuated adaptive capacities. Resilience frameworks must reconcile universal human needs with the idiosyncratic needs of targeted groups, precluding inequities emanating from a one-size-fits-all paradigm. Resilience capacities diverge across discrete urban precincts—for example, historic districts versus newly developed areas, and central conurbations versus peri-urban areas. Hence, comprehensive optimization of risk governance resource apportionment is requisite to enhance resilience. Additionally, resilience enhancement must balance the developmental aspirations of the current generation with the resource carrying capacity for posterity, eschewing trade-offs that compromise long-term resilience objectives for short-term developmental dividends.

The core agenda hinges on establishing a methodology for the rapid identification of vulnerable cohorts and fragile locales, alongside formulating a procedural framework for the allocation of limited risk governance resources that balances efficiency and equity. Concurrently, comprehensively embedding the principles of equity and justice in the entire lifecycle of urban resilience planning, implementation, and cultivation is imperative, thereby fostering a governance regime for inclusive urban resilience.

Agenda 4: Role configuration and action pathways of multi-stakeholders in urban resilience building

The multi-stakeholder synergy perspective centers on interactive relationships among diverse stakeholders in urban resilience governance. It underscores that resilience enhancement is not the sole responsibility of any single actor, but rather the synergistic outcome of the three core sectors: government, market, and society. Multi-stakeholder synergy constitutes a pivotal underpinning for urban resilience enhancement, with its role configuration and collaborative efficacy directly shaping a city's capacities for resistance, recovery, adaptation, and transformation.

Specifically, the government is responsible for top-level institutional design, cross-sectoral resource coordination for risk governance, and safeguarding the public interest. It thus establishes an inter-departmental joint response mechanism, addressing the fragmented governance challenges inherent in siloed departments. The market acts as a catalyst for technological innovation and capital mobilization. It guides enterprises in developing cost-effective resilience technologies (e.g., intelligent monitoring and disaster prevention infrastructure), engages in the development and maintenance of resilient infrastructure, and advances risk governance-linked insurance products to create a market-driven risk-sharing mechanism. Meanwhile, social actors—encompassing communities, residents, and social organizations—serve as grassroots implementers, ensuring the precise alignment of resilience interventions with grassroots needs through participatory governance, self-rescue, mutual aid, emergency drills, and demand articulation.

Building upon a multi-stakeholder collaborative framework, information is shared across the full risk response lifecycle. At the same time, this framework aligns government public-interest goals, market-driven incentives, and community livelihood priorities, thereby activating the intrinsic motivation of diverse stakeholders to engage in resilience-building. Moreover, leveraging digital information infrastructure for collaborative risk governance boosts cross-regional, cross-departmental risk management efficiency and accelerates the transition from fragmented resilience to a more holistic, integrated form.

The core proposition of this perspective lies in recognizing the roles and functions of multi-stakeholder collaboration in shaping urban resilience. It further entails formulating solutions-driven operational pathways for such collaboration, thereby advancing the continuous improvement of urban resilience.

3. Future urban resilience research: Problem-solving-driven theoretical synthesis

Moving forward, future urban resilience research should deepen the integration of multi-dimensional perspectives. It should also establish a holistic research framework that integrates theoretical synthesis, methodological innovation, and practical pathways.

First, the city should be conceptualized as an integrated whole; on this basis, a universal analytical framework for urban resilience should be established. Furthermore, it is imperative to explore the evolutionary dynamics of this holistic entity's resilience performance, clarify the operational mechanisms and influencing factors of holistic resilience, and lay a solid ontological foundation for the holistic practice of urban resilience.

Second, emphasis should be placed on innovating methodologies for modeling, simulating, and mapping cities as complex systems. Currently, spatiotemporally refined urban datasets are rapidly expanding. By integrating cutting-edge technical approaches including big data analytics, artificial

intelligence, and satellite remote sensing, dynamic variations in urban functions and residents' behaviors can be precisely captured—thereby furnishing novel technologies for the rapid identification of risk perturbations and rigorous urban resilience assessment.

Third, comparative studies should be conducted on urban resilience practices across countries, regions, and city typologies (e.g., megacities, secondary cities, coastal cities, and mountainous cities). In response to the inherent wicked nature of urban complex systems, it is critical to draw insights from proven resilience-enhancing implementation pathways, policy instruments, and engineering measures.

Finally, the tenets of fairness and justice should be embedded in the entire lifecycle of resilience governance. Priority should be given to the practical needs of vulnerable populations confronting diverse challenges, thereby promoting the holistic integration of urban resilience and inclusive development.

In summary, rethinking urban resilience from a multi-dimensional perspective does not negate traditional views of resilience, but rather represents an expansion and deepening of urban resilience research amid complex realities. It seeks to overcome the limitations of unidimensional research and more accurately respond to the demands for resilience development due to the complex interplay of urban social-ecological-technical systems.

Use of AI tools declaration

The author declares he has not used Artificial Intelligence (AI) tools in the creation of this article.

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Conflict of interest

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References

1. Xiang WN (2025) Introducing the IASGER cycle as an aid to ecopracticological research and writing. *Socio-Ecol Pract Res* 7: 267–274. <https://doi.org/10.1007/s42532-025-00230-3>
2. Folke C, Biggs R, Norström AV, et al. (2016) Social-ecological resilience and biosphere-based sustainability science. *Ecol Soc* 21: 41. <https://doi.org/10.5751/ES-08748-210341>
3. Yan WT, Ren J, Zhang SW, et al. (2022) Resilient urban planning in Shanghai: Key issues, general framework, and planning strategies. *Urban Plan Forum* 2022: 19–28. <https://doi.org/10.16361/j.upf.202203003>
4. Li ZH, Yan WT (2024) Service flow changes in multilayer networks: A framework for measuring urban disaster resilience based on availability to critical facilities. *Landsc Urban Plan* 244: 104996. <https://doi.org/10.1016/j.landurbplan.2023.104996>

5. Li ZH, Yan WT, Wang L (2024) Measuring mobility resilience with network-based simulations of flow dynamics under extreme events. *Transp Res D: Transp Environ* 135: 104362. <https://doi.org/10.1016/j.trd.2024.104362>
6. Amirzadeh M, Sobhaninia S, Sharifi A (2022) Urban resilience: A vague or an evolutionary concept? *Sustain Cities Soc* 81: 103853. <https://doi.org/10.1016/j.scs.2022.103853>
7. Liao KH (2012) A theory on urban resilience to floods—a basis for alternative planning practices. *Ecol Soc* 17: 48. <http://doi.org/10.5751/ES-05231-170448>
8. Yan WT, Li ZH (2023) Study on the resilience mechanism of urban spatial structure from the view of risk disturbance: Theoretical framework and empirical methodology. *Urban Plan Int* 38: 1–10. <https://doi.org/10.19830/j.upi.2023.269>
9. Helbing D (2013) Globally networked risks and how to respond. *Nature* 497: 51–59. <https://doi.org/10.1038/nature12047>
10. Vespignani A (2010) The fragility of interdependency. *Nature* 464: 984–985. <https://doi.org/10.1038/464984a>



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